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BOSTON UNIVERSITY

GRADUATE SCHOOL

Thesis:-

"The Geographical and

Bathymetrical Distribution of the Hydroids."

Submitted by

Rudolf Bennitt

(S. B., Boston University, 1920.)

In partial fulfillment of requirements for

the degree of Master of Arts.

1921.

Zoology
Hydroids
Title
Ser.cd.

CONTENTS.

	Page
Section I. Introduction	1
Hydroid families--taxonomy	4
Section II. Factors in distribution	10
1. Physical conditions	11
A. Salinity	11
B. Pressure	14
C. Light	15
D. Temperature	16
E. Movements of water	24
Waves	24
Tides	25
Ocean currents	26
F. Nature of the base of attachment	28
2. Biological conditions	32
Section III. Provinces and zones of depth	37
1. Provinces	37
2. Zones of depth	41
Section IV. Taxonomic distribution	42
1. Clavidae	42
2. Corynidae	43
3. Hydrolaridae	44
4. Bougainvillidae	44
5. Pennaridae	46
6. Eudendridae	47
7. Tubularidae	48
8. Halecidae	49
9. Campanulinidae	51
10. Lafoeidae	52
11. Campanularidae	55
12. Synthecidae	57
13. Sertularidae	58
14. Plumularidae	67
Section V. Summary	76
Section VI. Conclusion	88
Section VII. Bibliography	90

378.744
BO
A.M.1921
be

Pages

Section I. Introduction 1

Hydroid families--taxonomy 4

Section II. Factors in distribution 10

1. Physical conditions 11

A. Salinity 11

B. Pressure 14

C. Light 15

D. Temperature 16

E. Movements of water 24

Waves 24

Tides 28

Ocean currents 29

F. Nature of the base of attachment 29

2. Biological conditions 32

Section III. Provinces and zones of depth 37

1. Provinces 37

2. Zones of depth 41

Section IV. Taxonomic distribution 42

1. Clavidae 42

2. Corynidae 43

3. Hydrolaridae 44

4. Bougainvillidae 44

5. Pennaridae 46

6. Rodendridae 47

7. Tubularidae 48

8. Haleciidae 49

9. Campanulinidae 51

10. Lafoeidae 52

11. Campanulariidae 55

12. Syntheciidae 57

13. Sertulariidae 58

14. Plumulariidae 67

Section V. Summary 78

Section VI. Conclusion 88

Section VII. Bibliography 90

TABLES, MAPS, etc.

	Page
Map of the principal ocean currents of the world	27
Table #1. Distribution of the Clavidae and Hydrolaridae	43
Table #2. Distribution of the Corynidae	44
Table #3. Distribution of the Bougainvillidae	45
Table #4. Distribution of the Pennaridae	47
Table #5. Distribution of the Eudendridae	48
Table #6. Distribution of the Tubularidae	49
Table #7. Distribution of the Halecidae	50
Table #8. Distribution of the Campanulinidae	52
Table #9. Distribution of the Lafoeidae	53
Table #10. Distribution of the Campanularidae	56
Table #11. Distribution of the Synthecidae	58
Table #12. Distribution of the Sertularidae	60
Table #13. Distribution of the Plumularidae	68
Table #14. Geographical distribution by families and genera	90
Table #15. Bathymetrical distribution by families and genera	90

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THE GEOGRAPHICAL AND BATHYMETRICAL DISTRIBUTION OF THE HYDROIDS.

SECTION I. Introduction.

The hydroids, for many reasons, form an excellent subject for a distributional study. Besides being one of the most primitive and undifferentiated groups of the Metazoa, they enjoy the distinction of being one of the oldest metazoan groups in point of geologic time; their ancestors were the Graptolites, which flourished most abundantly during the Silurian, but whose earliest known remains are from Cambrian rocks, and which must therefore have arisen during the Archaean. The first fossil specimen which bears a direct resemblance to the hydroids of the present was found in Cretaceous rocks, and has been identified as a species of Hydractinia, one of the athecate hydroids. Probably at no time during their history have the hydroids been anything but a marine group, with the exception of the very few fresh-water forms which have been recorded up to the present time. There have thus been no such barriers to migration as have influenced the distribution of land animals, nor has the spread of the human race affected the distribution of the hydroids and other marine organisms except to a very slight extent, in a way to be noted later.

The hydroids are remarkable, in comparison with nearly all other marine animals, in their extremely wide and uniform geographic range, and in extending vertically from the

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The hydroids are remarkable, in comparison with nearly all other marine animals, in their extremely wide and uniform geographic range, and in extending vertically from the

shore to about 3,000 fathoms' depth. This not only indicates an exceedingly great adaptability to changing conditions of life, but also it is plain that many disturbing natural factors have entered into the lives of the ancestral hydroids to start such a spreading out from their regions of origin, and that their distribution is being constantly modified and extended by the same factors today as when the distribution began.

Ever since Trembley, in 1744, demonstrated the animal nature of hydroids, they have been collected and studied by a large number of investigators in all parts of the world, mostly during the last century. The various marine scientific expeditions, beginning, so far as data for the purposes of this paper are concerned, with the voyages of the "Rattlesnake" in 1852 and the "Challenger" in 1873-6, have brought in their collections of hydroids. The stocks contained in museums have been overhauled, and numbers of private collections have been described, so that in an up-to-date bibliography of the literature pertaining to the distribution of hydroids we have papers dealing with the hydroid fauna of a large portion of the shores and continental shelves of the world, with an extensive record of the dredging stations in deeper waters.

Up to the present time, however, there has been no comprehensive attempt to assemble the great volume of

accumulated data regarding the world-distribution of the hydroids. Many writers have fully discussed the hydroid faunas of certain regions; others have studied the influence of physical and biological conditions on the entire faunas of restricted regions; but no one has as yet combined the two in an attempt to explain the present distribution of the hydroids as seen in the statistics of the various investigators and expeditions, by summing up the physical and biological conditions affecting this one group.

The purpose of this paper, then, is twofold:-First, to sum up as briefly as possible the principal factors which in any way influence the life-history and distribution of the hydroids; second, to discuss in some detail the present distribution of each of the fourteen families of hydroids in turn. To this end I have attempted the well-nigh impossible task of recording all the known hydroids, with the localities and depths at which they have been found. Obviously such a list, which in tabular form accompanies Section IV of this paper, is incomplete. This is due in part to the limitations of library facilities, and in part to the much-tangled taxonomy of the group. I feel, however, that I have collected sufficient of the existing records so that, in spite of a very small number of omissions and repetitions, the conclusions drawn from the list as it stands are reliable for the entire group.

****

Although the systematic discussion of the hydroid families, genera, and species will not be taken up until Section IV of this paper, it seems best to insert at this point a rough classification of the families to be considered, together with a list of their recognized genera. The taxonomic key given below is translated from Dr. E. Stechow's second paper on the hydroids of the east coast of Japan (Stechow:1909). The list of genera is from the same paper, with a few additions and corrections where prevailing scientific usage has seemed to warrant them. The number of species to each genus is from my own list.

Corynidae:- Tentacles all capitate; sometimes the proximal whorl are filiform or tentacles may be entirely lacking:-

Acaulis	1	species
Actinogonium	1	"
Bibrachium	1	"
Ceratella	4	"
Cladocoryne	4	"
Coryne	15	"
Corynitis	1	"
Dicoryne	4	"
Dendrocoryne	2	"
Gemmaria	4	"
Halocharis	2	"
Hydrichthella	1	"
Hydrichthys	2	"
Hydrocoryne	1	"
Myriothela	7	"
Syncoryne	11	"

16 genera, 61 species.

Clavidae:- Tentacles filiform, scattered or (usually) in more than two whorls, occasionally reduced:-

Ascidioclava	1	species
Balella	1	"
Campaniclava	1	"
Clava	5	"
Cordylophora	2	"
Corydendrium	7	"
Endocrypta	1	"

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Clava	5	"
Cordylophora	2	"
Corydendrium	7	"
Endocrypta	1	"

Monobrachium	1	species
Rhizogeton	2	"
Rhizohydra	1	"
Tubiclava	5	"
Turris	1	"
Turritopsis	1	" 13 genera, 29 species

Hydrolaridae:- Only two filiform tentacles. Hypostome knobbed:-

Lar	1	species
		1 genus, 1 species

Bougainvillidae:- Tentacles filiform, in one whorl, hypostome conical. Hydranth not sharply marked off from hydrocaulus:-

Bimeria	12	species
Bougainvillia	8	"
Calyptospadix	1	"
Clathrozoon	1	"
Clavactinia	1	"
Clavopsella	1	"
Corynopsis	1	"
Cionistes	1	"
Hydractinia	25	"
Hydrodendrium	1	"
Keratosum	1	"
Parawrightia	1	"
Perigonimus	28	"
Podocoryne	8	"
Provutella	1	"
Stylactis	4	" 16 genera, 95 species.

Pennaridae:- Oral tentacles capitate, aboral tentacles filiform:-

Cladonema	2	species
Heterostephanus	1	"
Pennaria	4	"
Stauridiosarsia	1	"
Rhizotrichea	1	"
Vorticlava	3	" 6 genera, 12 species.

Eudendridae:- Tentacles filiform, in one whorl. Hypostome knobbed. Hydranth sharply marked off from hydrocaulus:-

Eudendrium	39	species
		1 genus, 39 species.

Monobrachium	1 species	
Rhizogeton	2 "	
Rhizohydra	1 "	
Tubiclava	5 "	
Turris	1 "	
Turritopsis	1 "	13 genera, 29 species

Hydrolaridae:- Only two filiform tentacles. Hypostome knobbed:-

Lar	1 species	
		1 genus, 1 species.

Bougainvillidae:- Tentacles filiform, in one whorl, hypostome conical. Hydranth not sharply marked off from hydrocaulus:-

Bimeria	12 species	
Bougainvillia	6 "	
Calyptospadix	1 "	
Clathrozoon	1 "	
Clavactinia	1 "	
Clavopsella	1 "	
Corynopsis	1 "	
Cionistes	1 "	
Hydractinia	25 "	
Hydrodendrium	1 "	
Keratosum	1 "	
Parawrightia	1 "	
Perigonimus	28 "	
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Eudendridae:- Tentacles filiform, in one whorl. Hypostome knobbed. Hydranth sharply marked off from hydrocaulus:-

Eudendrium	39 species	
		1 genus, 39 species.

Tubularidae:- All tentacles filiform, in two separate whorls.(see also Balella, of the Clavidae.):-

Amalthea	4	species
Branchiocerianthus	2	"
Corymorpha	7	"
Ectopleura	3	"
Gymnogonos	1	"
Hybocodon	2	"
Hypolytus	1	"
Lampra	5	"
Nemopsis	1	"
Pelagohydra	1	"
Tubularia	35	"

11 genera, 62 species.

Halecidae:- Hydrothecae flat, campanulate, operculum absent (ungedeckelt), hydrothecae lacking in the primitive forms, funnel-shaped or hemispherical. Hydranths very large, incapable of retraction into hydrothecae, often with a series of connections (Einschnürung) between the circlet of tentacles and the hydranth-body. Hypostome conical; occasional medusae:-

Campalecium	1	species
Halecium	55	"
Hemitheca	1	"
Hydranthea	2	"
Ophiodissa	6	"
Phylactotheca	1	"

6 genera, 66 species.

Campanulinidae:- Hydrothecae bell-shaped or tubular, free, always and invariably deep(i.e. with an operculum, except in Tetrapoma). Hypostome conical. Gonothecae always single, never in special groups. Medusae or sporosacs:-

Calycella	3	species
Campanulina	10	"
Cuspidella	5	"
Lafoeina	3	"
Lovenella	4	"
Operculariella	4	"
Stegopoma	2	"
Tetrapoma	1	"
Zydactyla	1	"

9 genera, 33 species.

Tubularidae:- All tentacles filiform, in two separate whorls.(see also Balella, of the Clavidae.):-

Amalthea	4	species
Branchiocerianthus	2	"
Corymorpha	7	"
Ectopleura	3	"
Gymnogonos	1	"
Hybocodon	2	"
Hypolytus	1	"
Lampra	5	"
Nemopsis	1	"
Pelagohydra	1	"
Tubularia	35	"

11 genera, 42 species.

Halecidae:- Hydrothecae flat, campanulate, operculum absent (ungedeckelt), hydrothecae lacking in the primitive forms, funnel-shaped or hemispherical. Hydranths very large, incapable of retraction into hydrothecae, often with a series of connections (Einschnürung) between the circlet of tentacles and the hydranth-body. Hypostome conical; occasional medusae:-

Campalecium	1	species
Halecium	35	"
Hemitheca	1	"
Hydranthea	2	"
Ophiodissa	6	"
Phylactotheca	1	"

6 genera, 66 species.

Campanulinidae:- Hydrothecae bell-shaped or tubular, free, always and invariably deep(i.e. with an operculum, except in Tetrapoma). Hypostome conical. Gonothecae always single, never in special groups. Medusae of sporosacs:-

Calycella	3	species
Campanulina	10	"
Cuspidella	5	"
Lafoeina	3	"
Lovenella	4	"
Opercularella	4	"
Stegopoma	2	"
Tetrapoma	1	"
Zydactyla	1	"

9 genera, 35 species.

Lafoeidae:- Hydrothecae deeply beel-shaped to deeply tubular(langröhrenförmig), free or sessile, mostly without septum between hydrotheca and stalk, always with basal space (Basalraum). Hydrothecal margin untoothed and usually without an operculum. Hypostome conical. Gonothecae mostly in special groups. Almost no medusae:-

Bonneviella	4	species	
Cryptolaria	11	"	
Grammaria	9	"	
Halisiphonia	1	"	
Hebella	11	"	
Lafoea	20	"	
Lictorella	9	"	
Scandia	1	"	
Toichopoma	1	"	
Trichydra	1	"	
Zygophylax	6	"	11 genera, 74 species.

Campanulariidae:- Hydrothecae on stalks, bell-shaped, free, no operculum, clearly marked off from their stalks; basal space between hydrotheca and stalk, separated by a diaphragm. Hypostome knobbed. Medusae or sporosacs:-

Campanularia	62	species	
Clytia	26	"	
Gonothyraea	7	"	
Obelia	27	"	
Orthopyxis	7	"	
Silicularia	8	"	
Thaumantias	1	"	7 genera, 138 species.

Synthecidae:- Hydrothecae arranged in two rows, smooth-rimmed, bilateral, operculum absent. Gonothecae always single. Hypostome conical. No medusae:-

Hypopyxis	1	species	
Lytoscyphus	1	"	
Synthecium	14	"	3 genera, 16 species.

Sertularidae:- Hydrothecae always with a flat operculum(except in the most primitive genera), sessile, bilateral, arranged in one row. Hypostome conical. No medusae:-

Abietinaria	20	species
Calamphora	1	"
Desmoscyphus	2	"
Dictyocladium	4	"
Diphasia	25	"
Hydrallmania	4	"
Idiella	1	"
Lineolaria	2	"
Odontotheca	2	"
Pasythea	2	"
Selaginopsis	20	"
Sertularella	96	"
Sertularia	60	"
Staurotheca	3	"
Stereotheca	1	"
Thuiaria	40	"
Thuiella	1	"
Thyroscyphus	5	"

18 genera, 289 species.

Plumularidae:- Hydrothecae sessile, bilateral, always in a single row (einreihig), operculum absent. Hypostome conical. Nematophores always present; no medusae:-

Acanthocladium	1	species
Acladia	1	"
Aglaophenia	88	"
Aglaophenopsis	3	"
Antenella	6	"
Antenellopsis	2	"
Antennopsis	6	"
Antennularia	12	"
Callicarpa	1	"
Calvinia	1	"
Cladocarpus	20	"
Diplopteron	3	"
Gattya	1	"
Halicornaria	23	"
Halicornopsis	1	"
Halopteris	1	"
Hemicarpus	1	"
Heteroplon	1	"
Hippurella	1	"
Lytocarpus	20	"
Monostaechas	2	"
Monotheca	2	"
Nemertesia	7	"
Nuditheca	1	"
Ophinella	1	"
Plumularia	79	"
Polyplumularia	2	"
Pycnotheca	2	"
Schizotricha	7	"
Sciurella	1	"
Streptocaulus	1	"
Thecocarpus	9	"

32 genera, 307 species.

Abietinaria	20	species
Calamphora	1	"
Desmoscyphus	2	"
Dictyocladium	4	"
Diphasia	25	"
Hydrallmania	4	"
Idiella	1	"
Lineolaria	2	"
Odontotheca	2	"
Phaythea	2	"
Selaginopsis	20	"
Sertularella	96	"
Sertularia	80	"
Staurotheca	3	"
Stereotheca	1	"
Thuiaria	40	"
Thuiella	1	"
Thyroscyphus	5	"

<u>15 genera, 289 species.</u>

<u>Plumularidae:-</u> Hydrothecae sessile, bilateral, always in a single row (einreihig), operculum absent. Hypostome conical. Nematophores always present; no medusae:-

Acanthocladium	1	species
Acladia	1	"
Aglaophenia	86	"
Aglaophenopsis	3	"
Antenella	6	"
Antenellopsis	2	"
Antennopsis	6	"
Antennularia	12	"
Callicarpa	1	"
Calvinia	1	"
Cladocarpus	20	"
Diplopteron	3	"
Gattya	1	"
Halicornaria	23	"
Halicornopsis	1	"
Halopteris	1	"
Hemicarpus	1	"
Heteroplon	1	"
Hippurella	1	"
Lytocarpus	20	"
Monostaechas	2	"
Monotheca	2	"
Nemertesia	7	"
Nuditheca	1	"
Ophinella	1	"
Plumularia	79	"
Polyplumularia	2	"
Pycnotheca	2	"
Schizotricha	7	"
Sciurella	1	"
Streptocaulus	1	"
Thecocarpus	9	"

<u>32 genera, 307 species.</u>

Total:- 150 genera, 1222 species.

There have also been a number of species to which I have seen reference made, but whose distribution I have been unable to learn. They are probably authentic, and are listed as follows:-

Aglaophenia parva (Pieper)
A. reflexa (Pennington)
Campanularia chinensis (Marktanner-Turneretscher)
Clytia flavidula (Metschnikoff)
Eudendrium armatum (Tichomiroff)
Ichthyocodium sarcotretis (Jungersen)
Lytoscyphus subrufus (Jäderholm)
Nudiclava monocanthi(Lloyd)
Perigonimus belgicae (Vanhoffen)
P. cirratus (Hartlaub)
P. corii (Hadzi)
P. georginae(Hadzi)
P. steinachi (Jickeli)
Ptilocodium repens (Coward)
Sacculina arenosa (Bale)
Sertularia humilis (Armstrong)
Zygodactyla crassa (Aggassiz)

****

Total:- 180 genera, 1552 species.

There have also been a number of species to which I have been unable to learn. They are probably authentic, and are listed as follows:-

Aglaophenia parca (Fleyer)
A. reflexa (Pennington)
Campanularia ontonensis (Mertsanner-Turnerfeldner)
Clytia flavidula (Metcalf)
Eudendrium armatum (Tidemitzoff)
Lentomycodium sarcotretia (Jungersen)
Lytocarpus subcurtus (Tiderholm)
Nudicilara monocanni(Lloyd)
Perigonimus polytoxo (Vanhoffen)
P. citratus (Hartlaub)
P. conii (Hadzi)
P. georginae(Hadzi)
P. steinachi (Tokuda)
Ptilocodium repens (Coward)
Sacculina arenosa (Hale)
Sertularia humilis (Armstrong)
Syncoryne ornata (Agassiz)

***

SECTION II. Factors in Distribution.

Throughout the animal kingdom, mode of life and distribution are largely the result of environmental conditions, and this is particularly true among the more primitive forms. Animals which spend most of their lives in a fixed condition are much more susceptible to surrounding influences than animals which possess the power of locomotion, since the latter may seek out more favorable environment while the former cannot. The hydroids are both primitive and fixed, and are therefore good subjects on which to study the effects of marine environment.

The conditions found in the sea group themselves naturally under two heads: first, the physical conditions; second, the biological conditions. The attempt will be made, in the next few pages, to demonstrate the effect of the various physical and biological factors upon the life and distribution of the hydroids.

1. Physical Conditions.

The conditions obtaining in the sea-water and on the sea-bottom are of course of the greatest importance in the life of any marine organism, and they will here be discussed under the following heads: A. Salinity; B. Pressure; C. Light; D. Temperature; E. Movements of water (tides and currents); F. Nature of the base of attachment.

SECTION XI. Barriers in Distribution.

Throughout the animal kingdom, mode of life and distribution are largely the result of environmental conditions, and this is particularly true among the more primitive forms. Animals which spend most of their lives in a fixed condition are much more susceptible to surrounding influences than animals which possess the power of locomotion, since the latter may seek out more favorable environment while the former cannot. The hydroids are both primitive and fixed, and are therefore good subjects on which to study the effects of marine environment.

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A. Salinity.

The percentage of salts in solution in the sea-water has been found by all records to be practically constant. The average is 35 parts per thousand, although in some regions the concentration becomes as high as 39 to 40 parts, or as low as 32 parts per thousand. The concentration rarely exceeds these limits of variation, except in such seas as the Baltic and Black Sea, where the salt water from the ocean forms but a small part of the water, as compared with an immense volume of fresh water poured in by the large rivers.

It will be seen at once that there must be a greater variety of concentration near the shores of a sea than in its depths. The influx of fresh water from the rivers, the large amounts of material received by drainage or stirred up by wave action, and the larger amount of rain-fall and evaporation relative to the total amount of sea-water would all act to change the concentration of salts in the shallow water near shore, where the absence of these conditions far from shore would make for greater uniformity.

Since the hydroids are almost universally a marine group, the presence of two or three well-defined fresh-water genera, including several species, has led naturally to numerous experiments on the effect of change in salinity upon various hydroids and medusae, and from this to speculation as to the probable relations of fresh-water and marine forms.

A. Salinity.

The percentage of salts in solution in the sea-
water has been found by all records to be practically
constant. The average is 35 parts per thousand, although
in some regions the concentration becomes as high as
38 to 40 parts, or as low as 32 parts per thousand. The
concentration rarely exceeds these limits of variation,
except in such seas as the Baltic and Black Sea, where the
salt water from the ocean forms but a small part of the
water, as compared with an immense volume of fresh water
poured in by the large rivers.

It will be seen at once that there must be a greater
variety of concentration near the shores of a sea than in
its depths. The influx of fresh water from the rivers,
the large amounts of material received by drainage or
stirred up by wave action, and the larger amount of rain-
fall and evaporation relative to the total amount of sea-
water would all act to change the concentration of salts
in the shallow water near shore, where the absence of
these conditions for from shore would make for greater
uniformity.

Since the hydrobia are almost universally a marine
group, the presence of two or three well-defined fresh-
water genera, including several species, has led naturally
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ity upon various hydrobia and mollusca, and from this to
speculation as to the probable relations of fresh-water
and marine forms.

It has long been known that many hydroids are able to live in water of varying degrees of brackishness. Lankester (1880) records the occurrence of species of Laomedea, Eucope, and Obelia on the West Boston bridge, exposed alternately to fresh and salt water with the change of tide. They were all in healthy condition and gave off large numbers of medusae. Mayer (1910) says that Syncoryne often grows in brackish pools, in about one-third saline water, and that another species of the same genus grows equally well in pure sea-water or in estuaries. All hydroids living in shallow water are exposed to more or less variation in salinity, especially those living near the mouths of streams, and yet no specific instance has ever been recorded of a hydroid whose form or development was in any way affected by change in salinity; it either lives in such surroundings or does not. Forms which live well in water of a great range of salinity have been called by Murray and Hjört euryhaline forms; those living in deeper water, where constant salinity prevails, they term stenohaline forms, and they claim that one of the reasons for the deeper habitat is the inability of such animals to withstand more than minute changes in salinity. The euryhaline forms, almost without exception, live normally in shallow water.

On the other hand, we find that some of the freshwater hydroids may grow well in brackish water. The

best-known of the fresh-water hydroids is Cordylophora lacustris (Allman). This has been recorded by Allman, Hincks, Norman, and many others from strictly fresh-water localities in Great Britain, and by Allman from the dock-piles in the estuary of the Clyde, in brackish water. In America, Heath has recorded it from the Illinois River, in fresh-water, while in the Woods Hole region it is recorded by the U.S.Bureau of Fisheries Survey (1911) in fresh or brackish ponds both on the mainland and on Martha's Vineyard. Boulenger (1908) has found Cordylophora in Lake Qurun, in Egypt, where the water is 1.34 % saline (brackish), and he states that the hydroid shows no tendency to grow in strictly fresh-water canals near the lake. Kirchenpauer found Cordylophora in the estuary of the Elbe.

These two sets of observations lead to the question: Did the marine hydroids originate from fresh-water forms like Cordylophora, or did the latter come originally from the sea? VonLendenfeld (1886) believed that the fresh-water hydroids, sponges, and rhizopods of Australia, because of their resemblance to those of Europe, were the ancestors of the marine forms, which were quite different from the corresponding European forms. But practically every other writer on the subject has believed in the marine origin of the fresh-water hydroids. Boulenger remarked that while Lake Qurun was now 150 miles from the sea, the two were connected during the Pliocene,

which may have been the time at which Cordylophora was introduced. Moore (1897-8) made a similar suggestion while discussing a medusa, Limnocnida, in Lake Tanganyika, in Africa. Allman suggests ships as a means of transporting Cordylophora up into the estuaries, whence they may have worked into fresh water. Altogether, from the evidence already noted, and from the fact that only half a dozen of the twelve hundred hydroids have been found in fresh water, the logical conclusion is that the present fresh-water forms were once marine.

We have already seen that salinity, among the marine hydroids, plays a minor part in distribution.

B. Pressure.

According to all available evidence, pressure exercises absolutely no influence on the distribution of the hydroids. Idiella pristis, one of the Sertularidae, has a bathymetrical range of 0-1343 fathoms, Campanulina denticulata ranges from 0-2845 fathoms, Hydrallmania falcata, another Sertularian, from 1-1100 fathoms, and a range of several hundred fathoms is common. In species having a wide bathymetrical range, the representatives taken from deep water differ in no way from the shallow-water forms. There are thus no adaptive modifications which could be traced to pressure.

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C. Light.

The photic zone, or the zone of penetration of light rays into the sea-water, extends at its maximum down to about 500 fathoms, while the actinic rays of light have been found to penetrate to about 833 fathoms. Has the distribution of light any effect upon the distribution of the hydroids, which extend far below the lowest point to which light could possibly penetrate?

Little or no work has been done on the direct influence of light upon the growth and distribution of the hydroids, and we know only that in general, for forms living in water less than 50 fathoms in depth, the presence of light is favorable to growth and the absence of light unfavorable to it. Mayer (1910) states that light is absolutely essential for the normal growth and regeneration of Pennaria tiarella, and, to a lesser degree, for that of Eudendrium ramosum; but other than this and one or two like records, there is little evidence to warrant more than this general statement.

One instance of protective coloration has been recorded. Hargitt (1908) says that Gemmaria gemmosa, one of the Corynidae, is invariably associated with pink or orange colonies of the bryozoa Schizoporella and Membranipora, and that the hydroid colony assumes the same color.

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5. Light.

The photic zone, or the zone of penetration of light rays into the sea-water, extends at its maximum down to about 600 fathoms, while the actinic rays of light have been found to penetrate to about 850 fathoms. Has the distribution of light any effect upon the distribution of the Hydroids, which extend far below the lowest point to which light could possibly penetrate?

Little or no work has been done on the direct influence of light upon the growth and distribution of the Hydroids, and we know only that in general, for forms living in water less than 30 fathoms in depth, the presence of light is favorable to growth and the absence of light unfavorable to it. Mayer (1910) states that light is absolutely essential for the normal growth and regeneration of Pennaria tiarella, and, to a lesser degree, for that of Eudendrium ramosum; but other than this and one or two like records, there is little evidence to warrant more than this general statement.

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For animals living below the photic zone, much significance has been attached to the prevalence of phosphor-

escent light at great depths. It is well known that a much greater proportion of deep-water hydroids are phosphorescent than of hydroids within the photic zone. Andrew Murray was the first to suggest the utility of this light, and Nutting (1899, 1901) has expressed the view that protozoa, crustacean larvae, and other minute animals and plants known to be phototropic, and which also form a large part of the diet of the abyssal hydroids, are attracted to the hydroids by their phosphorescent light, which is therefore of use in the acquiring of food.

The direct influence of light, then, is not indispensable to the economy of the hydroids. It does, however, make for a greater abundance of forms within the photic zone, and is therefore one of the essential conditions in an ideal environment.

The most potent influence exerted by light is an indirect one, namely, its influence on the marine algae. This is of great importance because of the widespread use of these plants by the hydroids as bases of attachment, a subject which will be discusses in Part F. of this section.

D. Temperature.

The surface temperature of the ocean varies from 26 to 96 degrees F., and the bottom temperature from below 30 to 70 degrees F. in various parts of the world. There is considerable seasonal variation in the surface and

shallow-water temperature of any region. At a depth of 100 fathoms, this range may exceed 20 degrees F., and it becomes progressively greater nearer the surface and smaller in deeper waters, below 100 fathoms. Obviously the hydroids, with their extensive distribution, both as to breadth and depth, are exposed to greatly varying conditions of heat and cold.

McCrady (1857) was one of the first to speculate on the relation of temperature to the distribution of hydroids and medusae. He compared the faunas of Charleston Harbor and Messina, Sicily, both places having mean annual temperatures of about 66 degrees F., and found a number of common forms. He found also that the fauna of Charleston was related to that of Long Island Sound, Boston Harbor, and Grand Manan, and also to that of western Europe, from the British Isles to north-west Africa. He believed temperature to be the principal factor in this relationship.

There is evidently a maximum range of endurable temperature and a range of most favorable temperature for every animal. For hydroids which have a cosmopolitan distribution in depth, the range of both favorable and endurable temperatures is very high, and they are able to live in water of almost any temperature within the limits for their kind. The great majority of all the hydroids, however, depend largely on temperature to make their habitat favorable or unfavorable, and it has long been

recognized that certain groups of hydroids are now found predominantly in warm water, certain others in cold water, and still others in both.

Fewkes, in 1888, noticed that while some marine invertebrates could range from 1-1000 fathoms, a very slight change in temperature would produce an instant effect. He also called attention to a relation between the polar surface fauna and that of greater depths in lower latitudes, taking this to indicate a repetition among marine animals of Humboldt's Law, which deals with the modification of plants with altitude and the correspondence of latitude with altitude. Unfortunately, since Fewkes' paper there has been no real comparison of these two faunas, so that beyond a few cases in which the law doubtless holds true we have no evidence to substantiate his theory.

It would perhaps be well at this point to review the early history of the hydroids, since the changes through which they have passed have been primarily the result of temperature conditions, all other conditions being secondary.

During the Tertiary period, the water in the polar regions was of a much higher temperature than it has been at any time since, and the hydroids are generally conceded to have arisen within the polar areas. There are three reasons for this concession:- First, with only two or three notable exceptions, the hydroid families are at present

mainly temperate or polar or both in their geographical distribution; the exceptions (see Plumularidae), although apparently not of polar origin, may nevertheless be traced with a considerable degree of continuity through their migration from a cold-water source to their present tropical habitat. Second, with the above-mentioned exceptions, hydroids at present reach their maximum size and diversity in colder waters. Third, such scattered geologic evidence as is available regarding the preglacial distribution of the hydroids points to the fact that, in the north at least, hydroids extended their range into even higher latitudes than at present. There is no geologic evidence to show that the geographical range of any hydroid differed from this general plan during preceding periods.

The great arctic and antarctic glaciers of the Pleistocene caused a drop in temperature, during which a large number of hydroids, unable to stand the change, were eliminated from the polar regions, only their representatives in temperate or tropical waters surviving. At the end of the Pleistocene there still remained in arctic and antarctic waters representatives of the essentially polar groups, and these have become the holarctic or circumpolar forms of today. Those which were forced out by the cold continued their spread through temperate and tropical waters, and made up the groups which today are identified with warmer waters.

Since that time, distribution of two kinds has been

going on: horizontal and vertical. The former has been impelled largely by ocean currents, and has resulted in some cases in a secondary movement of tropical or temperate forms toward the poles. There is reason to believe from the evidence of fossils that isolated arctic regions, such as Norway and the east coast of Greenland, were warmer after the glacial era than they are now, and this can have been due only to contact with warm currents, such as the Gulf Stream, which even today sends a branch as far north as Spitzbergen. But this movement is relatively unimportant. Its most striking example among the hydroids is the finding of three species of Aglaophenia, a tropical Plumularian, in a "warm spot" off the coast of Norway by M. Sars.

Vertical distribution has not been impelled by any particular force, but has been simply the natural spread of any animals through a region so long as favorable environment exists. This vertical spread is of course governed by the animal's ability to adapt itself to changes in light, temperature, pressure, food supply, and base of attachment. At about 100 fathoms, the world over, is a region known as the "mud-line," the region in which all the fine organic detritus from shallower waters of the continental shelves comes to rest. This line forms a fairly distinct boundary between the region of light, higher temperature, and abundant algae above, and the cold, dark, barren region below. A surprisingly large number of hydroids have never

penetrated below the mud-line, and these are almost universally forms which in other ways have shown themselves unable to stand a very low temperature. Hydroids found below the mud-line, on the other hand, are nearly all widely distributed, indicating greater hardiness and adaptive power.

A feature common to hydroids inhabiting very cold water, either in polar regions or at great depths, is the absence of free medusae. There are almost none in polar waters, and a very rare case of a medusa found below the mud-line was recorded by Sars, who dredged a medusa-bearing species of Perigonimus from 400 fathoms. This was probably in one of the numerous warm spots off the coast of Norway, since medusae are almost never found below the mud-line. This indicates that temperature undoubtedly affected the hydroids in relation to their mode of reproduction. Those having a free medusa-stage are for some reason unable to stand great cold, and their spread is accordingly limited, while those having no free medusae are more widely spread, in all temperatures. This is supported by the fact that in temperate waters, medusae appear only in the warm season, and in the tropics all the year around. Verrill and Allen's rule for birds and Merriam's for terrestrial plants and animals certainly seems to hold true in the case of the hydroids, namely, that the limits of distribution are determined by the temperature at the breeding season only.

In this way we account for the striking similarity

between the polar shallow-water faunas and that at greater depths nearer the equator. We can see also that temperature is a particularly important factor in regulating the migrations of the hydroids from their early polar habitat to the more extensive regions which they now occupy.

Temperature may also be called to account for the greater number of species and individuals in the tropics than in colder waters, and the larger number in shallow-water than below the mud-line. Van t' Hoff's Law, that the velocity of a reaction is doubled or trebled when the temperature is increased by 18 degrees F., is equally applicable to biochemical reactions. The rate of metabolism, of reproduction, and hence in the long run of differentiation into species, is thus more rapid with the higher temperature which obtains in the tropical regions, and these in consequence have the most abundant and varied faunas.

There is a theory of bipolarity which assumes the presence of an archaic abyssal fauna, similar in character to both arctic and antarctic faunas; the theory is based on the apparently large number of species common to both. Of the 46 species of hydroids in the accompanying lists which are recorded from the Antarctic province, only 18 are likewise recorded from any point north of western Europe (Hartlaub records 17 bipolar species), and of these 10 have a cosmopolitan distribution effected by other means. Regarding the 8 which remain to indicate

any such ancestral abyssal hydroid fauna, there is such a strong probability that they have been overlooked in the intervening provinces and do actually occur in the more moderate depths between, that this theory is considered unfounded with regard to hydroids, just as others have shown it to be unfounded with regard to other marine animals.

Unlike many other groups, the hydroids do not require a high temperature to attain their maximum size. A large number of the largest hydroids, including some of the Tubularidae, Lafoeidae, and Sertularidae, live exclusively in arctic or subarctic waters, and a number of writers have noticed that in the cases of hydroids found in cold and warm waters alike, the cold-water forms are the more robust.

Hilgendorf (1898) records an interesting example of adaptation to extreme cold. Obelia nigrocaulus (Hilg.) has developed a deeply pigmented black perisarc as a protection against the winter frosts.

The one matter remaining to be discussed under the head of temperature is seasonal variation in distribution. In the frigid and torrid zones, where the temperature of the water remains nearly constant throughout the year, seasonal variation of any sort is negligible. In the temperate zones, however, where the temperature at different seasons may vary 70 degrees F. or more, hydroids are subjected to great changes. One resulting effect is to restrict the medusa-bearing type of reproduction to the warm

season, and this has already been noted. There is, however, no evidence for any seasonal migration of hydroids. The common Tubularia crocea, for example, flourishes best during the warm season along the New England coast, but it is present during the winter as well, although the hydranths are lost and the colony is in a quiescent state. The same is true among all "warm-season" hydroids of the temperate zone, and there is, therefore, no seasonal variation in the geographic distribution.

E. Movements of water:-

These may be divided roughtly into three classes:- waves, tides, and ocean currents, and they will be dissussed in this order.

Waves.

Normal wave action has been perceptible at a depth of 200 fathoms, where a storm is reported to have moved fine particles of sand, in a region off the north coast of Scotland. But any influence of the waves on animals living within their range is limited practically to the Littoral and Laminarian Zones of Forbes, that is, to the lowest level of the spring tides. Within these zones the water is constantly agitated, and this has been shown to have its effect on some hydroids. Bougainvillia fruticosa (Allman) has turned out to be an environmental form of B. ramosa (van B.) caused by wave influence. Hallez (1906) has shown by

experiments on Eudendrium, Halecium, Obelia, Sertularella, Hydrallmania, and several other hydroids, besides the bryozoan Bugula, that movements of the water tend to develop more than the normal amount of stolons, and to consolidate the colony into a different form more adapted to resist the agitation. These changes are purely secondary and are not transmitted to subsequent generations bred in quiet water, but the fact remains that so long as the hydroids are kept in the troubled shore waters, the environmental form persists. Since Hallez' subjects are all so distinct from one another, all but two being in different families, we can safely say that wave action develops modified environmental forms from hydroids normally growing in quiet water.

Tides.

The Littoral Zone, that between the normal tide-marks, is peopled by hydroids which are able to exist for half or more of their lives out of water. This indicates that such forms are hardier, and can stand more pronounced changes than those which must live wholly below the littoral. Clava, Campanularia flexuosa, Coryne pusilla, Gonothyraea loveni, and Sertularia pumila are good examples of littoral hydroids, and yet none of these are restricted to the tidal area, nor is there any difference between the littoral and deep-sea representatives of the same species. We may conclude, therefore, that while hydroids within the tidal limits

can stand more and greater changes than others, yet tides do not affect their form or distribution to any noticeable degree.

Ocean Currents.

Fewkes (1888) has said that the two great tendencies at work in the modification of the rule of meridional migration---i.e.migration from the poles---were the warm currents carrying tropical animals into higher latitudes and the cold currents carrying polar animals toward the equator. That this is true will readily be seen in the case of the hydroids by recalling that all hydroids have a free-swimming planula- or medusa-stage, or both, that their bases of attachment are often carried about by currents, and that even the hydroids alone have been known to live and reproduce in a free, floating condition. (Fraser,1916; Dendy,1902.)

The importance of the medusa-stage in exposing the hydroids to the influence of currents is self-evident, especially since practically all the medusa-bearing hydroids live in shallow water, less than 100 fathoms in depth. Obelia geniculata, perhaps the most cosmopolitan geographically of all the hydroids, doubtless owes much of its distribution to the action of currents on its hordes of medusae. But although this element is an important factor in the distribution of the large numbers of species producing free medusae, it is not of great importance among the cosmopolitan

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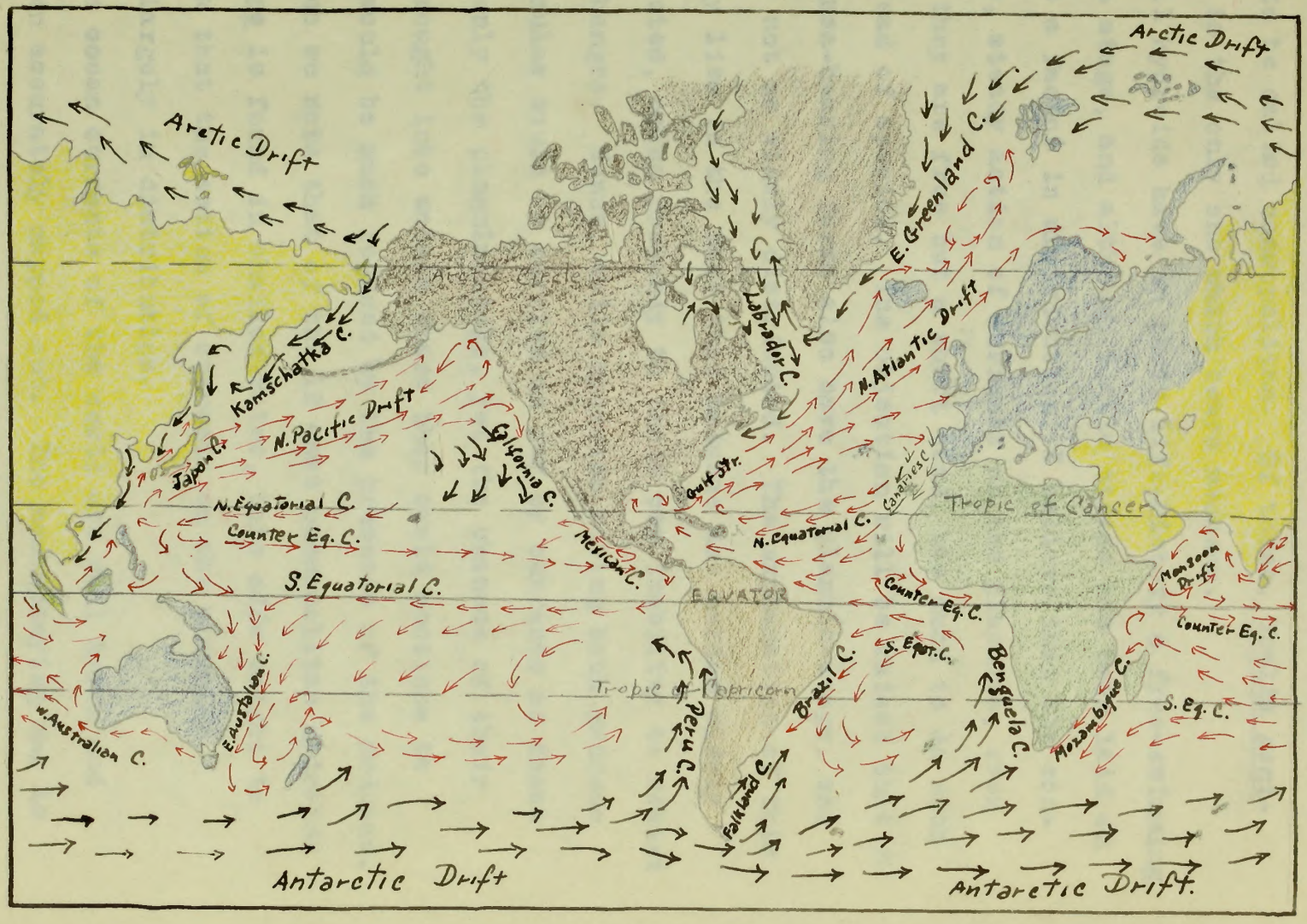
The Principal Ocean Currents of the World.



.... Cold Currents

--- Warm Currents

The Principal Ocean Currents of the World

forms. Of the 27 provinces named in the check-list, 15 hydroids have been recorded from 12 or more, giving them claim to be called cosmopolitan. Of these, Obelia geniculata is the only one which bears medusae.

All hydroids have in their life-history a free-swimming planula stage, and although little stress has been laid on this as a factor in distribution, I believe that the continuous, steady action of currents on the planulae, even though they are free but a short time, has much to do with the spread of species. The objection will be raised that the medusa-bearing forms also have the planula-stage, and yet are not so widely distributed. The explanation of this probably lies in the fact that medusae are seldom widely distributed, owing probably to their own inability to resist great changes. Hence, while hydroids having both medusae and planulae would be carried as far by currents as those having only the planula-stage, yet the chances of their being brought into waters where they could continue to thrive would be much reduced by the presence of the medusae.

When we note that of the 15 most cosmopolitan hydroids every one is found in shallow water, this adds weight to the idea that the action of currents on the planulae figure largely in distribution.

The ocean currents of the world are well known and have been accurately mapped out. The accompanying map is only for guidance while reading this paper. The following

discussion of the distribution of the separate families will show the marked influence of the currents in spreading the hydroids through the seas, by transporting medusae or planulae, the hydroids themselves, or the bases to which they are attached.

F. Nature of the Base of Attachment:-

The hydroids are attached, in the main, either to plant structures or to fixed physical structures, and, like all other attached animals, their distribution is governed to a large extent by the distribution of favorable bases of attachment.

Considering first the plants, we find attached to them hundreds of species of hydroids, to whom their elasticity affords protection from the full force of the waves and access to a more ample food-supply. The algae, which make up the overwhelming majority of the marine plants, are found only to a depth of 50 fathoms at most, and are rare below 20 fathoms. Below the region of vegetation are found only diatoms, and in the extreme depths of the sea there is no plant life at all. One would expect that the hydroid life is less abundant below the zone of vegetation, since it is there deprived of one of its most favorable living conditions, and this is found to be true; the hydroids are most abundant in the Littoral, Laminarian, and Coralline Zones of Forbes---down to 50 fathoms---and below that are much reduced in number and variety.

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In the Littoral and Laminarian, the algae are predominantly brown, and such common forms as Fucus, Ascophyllum, Laminaria, Sargassum, and Macrocystis have large numbers of hydroids identified with them. In the Coralline, red algae predominate, and a few hydroids, of which Clytia johnstoni is the most common, are known to exhibit a predilection for red algae. No cause for this discrimination among the hydroids has been suggested.

The floating masses of seaweed are the most important carriers of hydroids from place to place, with the aid of the ocean currents. The hydroids of Bermuda were brought there almost exclusively by Sargassum floating in the Gulf Stream. Many tropical hydroids have been carried into high latitudes by the same means, and because of the abundant food-supply, in the multitude of minute animals which are always associated with floating masses of seaweed, hydroids may be carried for great distances in a living condition. The greatest distance traversed by a hydroid in this way is recorded by Ritchie (1907), who discovered an Australian hydroid, Sertularia elongata, in the North Sea, having been brought in by one of the fishing boats. It grew on a marine species of the Potamogetonaceae not found in the North Atlantic, but common in the Indo-Pacific and Australia, and had undoubtedly been carried to the North Sea by ocean currents. This is unusual, but the large proportion of the hydroids of any region which are recorded "on floating seaweed" testify to the continual and widespread distribution

of hydroids by this means.

The fixed physical structures include the different conformations of the bottom, shells, wharf-piles, and the like. Comparatively few species, and only large colonies, are found actually attached to wharf-piles, which are only a man-made form of sea-bottom. Most of the hydroids reported as growing on piles live on the algae which coat the piles.

The nature of the sea-bottom may be roughly characterized by one of these four terms:- rocky, gravelly, sandy, and muddy. I have never seen any actual record of a hydroid growing on a muddy bottom, which is eminently unfitted for their mode of life. There are a few hydroids, of which Corymorpha is a good example, which are provided with a stalk, such as will ceep them rooted in a sandy bottom. These are few in number, and the sandy bottom is practically barren of hydroid growth. Likewise, a few hydroids, such as Antennularia antennina and Thecocarpus myriophyllum have developed a felt-work of root-fibers for attachment to a gravelly bottom, but these again are few in number. Rocks and stones afford the most favorable attachment for hydroids, and here are found a large variety, which have developed stolons to adapt them to this mode of life.

Hydroids are attached to a number of structures other than those already mentioned, of which the most important is the molluscan shell. Shells are peculiarly adapted to hydroid growth, being at once hard and smooth, and a larger

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number of hydroids occur on dead shells than on any other structure of the sea-bottom. Particularly below the zone of vegetation, shells are the most important lodging-place for hydroid life.

The larger hydroid stems are frequently overgrown by smaller epizoic forms, and are an important, often the only, base of attachment for a large number of hydroids. As many as half a dozen different epizoic species may often be found growing on a single cluster of large stems.

A few instances have been recorded of hydroids growing on live molluscs. Tubiclava cornucopiae grows on Venus, Dentalium, Astarte, etc.; Trichydra pudica on Pecten; Abietinaria abietina on various living molluscs; etc. The absence of hydroids from the surfaces of living mussel-shells, with their presence on dead shells nearby, a circumstance which I have often observed at Woods Hole, has never been satisfactorily explained; unless it be true that the periostracum of the living mollusc on shell offers some impediment to attachment.

Membranous or leathery worm-tubes, such as those of Chaetopterus, Sabella, etc., give lodgment to a few hydroids, among them Halecium halecinum, Plumularia catharina, Sertularella gayi, and Lar sabellarum.

A number of small Campanularians grow on Bugula; Gemmaria gemmosa, Halecium tenellum and others have been found on encrusting bryozoa.

Plumularia setacea, Halecium labrosum, Sertularella gayi, and Plumularia catharina are among those which grow on ascidian tests, while Endocrypta huntsmani grows with the branchial chamber of an ascidian.

Plumularia setacea has been found on the bread-crumb sponge, Halichondria. Borradaile records Campanularian hydroids from a sea-turtle, a sea-snake, and corals. Stechow found Perigonimus repens and Gemmaria gemmosa living on a live holothurian, Synallectes chuni.

Several hydroids have been found to be parasitic on fishes. Large crustaceans furnish an excellent attachment for many. Among the former are Hydrichthys (on Seriola), Nudiclava monocanthi (on a scorpaenoid fish), Perigonimus pugetensis (on Hypsagonas), and Podocoryne minoi (on Minous inermis). It is an interesting and unexplained fact that these and all other truly parasitic hydroids belong to the Gymnoblastea or athecate hydroids.

As a number of writers have pointed out, a favorable base of attachment is absolutely essential to the existence of a hydroid individual or colony. Supposing the colony to be brought to a region by one of the means above mentioned, its planulae cannot survive unless they find a suitable surface for attachment. It is this factor that has made certain regions barren of hydroid life and others overcrowded; it is therefore of primary importance in distribution.

2. Biological Conditions.

Allen (1898) has concisely classified the biological influences surrounding any marine animal as follows:-

1. An organism may be advantageous to another:

a. By serving as its food-supply.

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a. By serving as its food-supply.

b. By serving as its fixed base.

c. By serving as its movable base.

d. By bringing food to it, via currents, etc.

e. By affording protection, shelter, or concealment.

2. An organism may be disadvantageous to another:

a. By preying upon it.

b. By fixing on it so as to destroy it.

c. As competitor for limited food-supply or fixing-space.

These are all external conditions. To them may be added the mode of reproduction, which is an internal condition.

The hydroids are advantageous to other animals in nearly all of the ways above mentioned. They serve as the food-supply of some animals, particularly the nudibranch molluscs and small gastropods which are nearly always to be found in great abundance crawling through a large hydroid colony; the little file-fish (Ceratacanthus) is said by Hargitt to feed on the polyps of Pennaria tiarella, and hydroids have on several occasions been found in the stomachs of larger fishes, but it is not certainly known whether they formed part of the diet or were taken in along with other material.

Hydroids have comparatively few parasites. In the many recorded instances of other hydroids and stalked protozoa growing on a hydroid stem, it is rarely true that this is anything but an epizoic condition, the epizoan deriving no nourishment from the "host." Corydendrium parasiticum, found on Eudendrium ramosum, is one of the few instances of parasitism on a hydroid host.

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As has been noted before, the hydroid stem forms an excellent attachment, not only for other hydroids, but for protozoa, bryozoa, and even tunicates. For so small an animal as could live in this way, the base formed by the hydroid stem is certainly movable rather than fixed, in that it moves the epizoa about through the water for comparatively great distances, and is thus of advantage to them.

In many well-known cases, hydroids afford concealment to the surfaces on which they grow. Hydractinia echinata and Podocoryne carnea, commonly found on small gastropod shells inhabited by hermit-crabs, furnish more or less concealment for the crab, in return for being carried about to fresh feeding-grounds. The several species growing on fishes also probably give the fish a useful and protective deceptive appearance. The number of hydroids growing on crabs and other large crustaceans is too numerous to mention; in all cases they afford a measure of concealment to the "host."

Such hydroids as grow on fishes, crustaceans, and sponges, as well as Endocrypta huntsmani, undoubtedly benefit by the current created by the animals on which they grow. On crabs, they often grow around the mouth-parts, and on fishes around the gill-openings. The whole food-supply of Endocrypta is brought to it in this way.

The hydroids are a beneficent group; the good they do far outranges the harm. Almost no instances are known in which the presence of hydroids is a direct detriment to the

welfare of any animal. Hydroids which grow upon other animals never grow in such profusion as to kill them, and usually they are of some benefit to them. The only groups of animals which suffer through the presence of hydroids are the small crustacea and their larvae, the diatoms(plants), and the protozoa, which form the largest part of the dietary of the hydroids. Occasionally, hydroids occur in such profusion as to practically exclude all other forms of life except such as will live with or on them. Tubularia, Clava, Eudendrium, Syncoryne, Schizotricha, and many others cover entire piles or square yards of rock. But contrast this with the immense areas covered by scallops and mussels, sponges, small crustacea at the breeding-swarm, feather-stars (Sars, N.N.Atl.Exp.) and Littorina, throughout which these animals consume practically the entire available food-supply, to the detriment of all other life within these areas. The hydroids are not a serious competitor for the food-supply wherever they grow.

A thick growth of algae is often sufficient to kill a hydroid colony;after or during the reproductive season of Pennaria, Tubularia, Obelia, Eudendrium, Sertularia, and many others, the stems become overgrown with minute brown algae, and occasionally green algae; and although in the case of the athecate hydroids the hydranths are not lost for some time after that, the growth of algae is always a certain forerunner of the decline of the colony into a state of quiescence or death.

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A word should be said at this point regarding the effect of isolation on the formation of new species. The tendency of two parts of any plant or animal group to form divergent lines when widely separated from each other for long periods of time is well known. That this tendency is equally operative among the hydroids is shown by the large numbers of "local" species referred to in the later sections. Isolation is doubtless a factor in distribution, but its apparently great significance among the hydroids is partly due to the large number of dredging records which come from only one province. The local species have been largely discounted in drawing general conclusions as to the distribution of any group of hydroids.

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SECTION III. Provinces and Zones of Depth.

Before discussing the geographical and bathymetrical distribution of the separate families, and in some cases of the genera, it is essential that we outline the faunal provinces and the zones of depth which are to be used in the next section.

1. Provinces.

The most complete division of the seas of the world into faunal provinces was made by the "Challenger" (1873-6), and since then there has been no new division, so that I take the provinces outlined by the "Challenger" as the basis for my own tables. But since the "Challenger" provinces number 42, it is palpably impossibly to include them all in a single chart, and yet have that chart simple enough to be understood, so it has been necessary to consolidate various groups of the "Challenger" provinces into single provinces for the purposes of this paper. The "Challenger" provinces, moreover, are of all sizes, determined largely by whatever localities the ship visited. For example, the Bermudas are a separate province, even though their fauna is practically identical with that of the West Indies, which are called another province. There are so many such cases in the "Challenger" list that a revision seems necessary, if for no other reason. I have therefore so modified and condensed the list of "Challenger" provinces that we may have, first, a smaller number, for purposes of study;

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second, each province with reasonably constant conditions throughout; third, each province marked off from its neighbors in some way, so that different sets of conditions are found in each.

A list of the provinces as outlined by the "Challenger" reports is here given:-

1. Brazilian
2. Caribbean
3. Bermuda
4. New England
5. Labrador
6. Arctic American
7. E.Greenland
8. Icelandic
9. Arctic European
10. Norwegian
11. North Sea
12. Lusitanian
13. Mediterranean
14. Adriatic
15. Black Sea
16. W.African
17. Insular(between S.America & Africa)
18. S.African
19. Tristan da Cunha
20. E.African
21. Red Sea
22. Indian
23. Mascarene
24. Kerguelen I.
25. Malay
26. N.Australian
27. S.Australian
28. New Zealand
29. Polynesian
30. Japanese
31. Kamschatkan
32. Bering Sea
33. Arctic Asiatic
34. Alaskan
35. Californian
36. Mexican
37. Insular (Galapagos Is.)
38. Peruvian
39. Magellanic
40. Argentinian
41. South Georgian
42. Antarctic

The provinces used in this paper will be as follows:-

1. Brazilian
2. West Indian
3. Eastern North American
4. Arctic Atlantic
5. Arctic European
6. Continental
7. Mediterranean
8. West African
9. South African
10. East African
11. Kerguelen
12. Mascarene
13. New Zealand
14. South Australian
15. North Australian
16. Oceanic
17. Japanese
18. Hawaiian
19. Arctic Asiatic
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Space will be given here to outlining the boundaries of these 27 provinces. By reference to the map of ocean currents the principal currents passing through each province may be seen.

1. Brazilian:- East coast of South America, from Trinidad to Buenos Ayres.

2. West Indian:- Caribbean Sea, Gulf of Mexico, West Indies, Bahamas, Bermudas, and the coast of the United States as far north as Charleston, S.C.

3. Eastern North American:- East coast of North America from Charleston, S.C. to Labrodor.

4. Arctic Atlantic:- Labrador, Davis Strait, Baffin Bay, Greenland, Iceland, and Jan Mayen.

5. Arctic European:- Spitzbergen, Franz Josef Land, Nova Zembla, and the northern coasts of Europe, including Norway.

6. Continental:- West coast of Europe from the North Sea to Gibraltar, including the Azores.

7. Mediterranean:- Mediterranean and Adriatic Seas. The conditions in the Black Sea are unfavorable for hydroid growth and there are no records of hydroids from that region, so it is not included in this province.

8. West African:- West coast of Africa, from Gibraltar to the Tropic of Capricorn, including the Canaries, Madeiras, Cape Verdes, Ascension I,, and St. Helena.

9. South African:- The coasts of Africa south of the Tropic of Capricorn, including Tristan da Cunha.

10. East African:- East coast of Africa north of the Tropic of Capricorn, including the Red Sea.

11. Kerguelen:- Kerguelen I., placed in a separate province because of isolated position and special fauna.

12. Mascarene:- India, Burma, Ceylon, and all neighboring islands.

13. New Zealand:- New Zealand and the surrounding islands.

14. South Australian:- South and south-east coasts of Australia, and Tasmania.

15. North Australian:- North-west, north, and north-east coasts of Australia.

16. Oceanic:- All the islands of the southwestern Pacific, from the Malay Peninsula and the Philippines to 135 degrees W. longitude.

17. Japanese:- Formosa, the Yellow Sea, Japan Sea, Japan, Ochotsk, Kamschatka, and the Kurile Islands.

18. Hawaiian:- Placed in a separate province because of its isolation and fauna. Hawaiian Islands.

19. Arctic Asiatic:- Northern Siberia and Kara Sea,

20. Arctic Alaskan:- Bering Sea and the coasts of Alaska north of the Aleutian Is.

21. South Alaskan:- West coast of North America from the Aleutian Is. to and including Puget Sound.

22. Californian:- West coast of the United States.

23. Mexican:- West coast of Central America from California to Panama.

24. Peruvian:- Entire west coast of South America, from

10. Near African:- East coast of Africa north of the Tropic of Capricorn, including the Red Sea.

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23. Mexican:- West coast of Central America from California to Panama.

24. Peruvian:- Entire west coast of South America, from

Panama to the southern extremity of Chile.

25. Magellanic:- Straits of Magellan, Tierra del Fuego, etc.

26. Patagonian:- East coast of South America south of Buenos Ayres, including the Falkland and South Georgian Is.

27. Antarctic:- All stations south of the 60th parallel throughout the world.

2. Zones of Depth.

As has already been noted, very few species of hydroids are confined in their bathymetrical range to either the Littoral or Laminarian Zones of Forbes. It has seemed best, therefore, to place the waters down to a depth of 20 fathoms in the first zone, thus including the region of densest vegetation. The second zone, from 20 to 50 fathoms, extends to the lower limit of vegetation, and the third, from 50-100 fathoms, approximately to the mud-line,,the lower limit of wave action. The region below the mud-line, of practically uniform physical characteristics, has been arbitrarily divided, following the example of the "Challenger" reports and of Nutting.

The zones of depth used in this paper are as follows:-

Zone I. 0-20 fathoms.
" II. 20-50 fathoms.
" III. 50-100 "
" IV. 100-200 "
" V. 200-500 "
" VI. 500-1000 "
" VII. 1000-1500 "
" VIII. 1500-2000 "
" IX. 2000-2500 "
" X. 2500 fathoms and over.

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" IV. 100-200 "
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" VI. 500-1000 "
" VII. 1000-1800 "
" VIII. 1800-2000 "
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" X. 2500 fathoms and over.

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SECTION IV. Taxonomic Distribution.

1. Clavidae.

The Clavidae and Corynidae are the two most primitive hydroid families.

The Clavidae are a small family, including 13 genera and 29 species, practically confined to shallow water; only 4 species are found at a depth greater than 20 fathoms. The geographical distribution of the family is largely in the North Atlantic Ocean, and only 12 species are found outside that region.

To this family belongs the most important fresh-water genus, Cordylophora (Allman), and this has for obvious reasons been omitted from this table of marine distribution. Of the two authentic species, C. lacustris (Allman) has been recorded from Great Britain, Western Europe, Egypt, Scandinavia, North America, the Black Sea, and New Zealand; the other, C. whiteleggi (vonLendenfeld) is recorded only from South Australia, and is quite possibly only an environmental form of C. lacustris. As has been noted before, Cordylophora occurs in waters of a fairly wide range of salinity; it has never been found at a greater depth than one or two fathoms.

The family is about evenly divided between species producing medusae and those giving off only planulae, and the former, among which are Clava, Rhizogeton, and Tubiclava, enjoy as wide a distribution as do the latter, which indlude Corydendrium, Turris, Turritopsis, and Campaniclava, so that the method of reproduction has little to do with the distribution. The large number of genera in proportion to species,

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Abbreviations for provinces:-

Pat.---Patagonian
Braz.--Brazilian
W.I.---West Indian
E.N.A.--Eastern North American
Arc.Atl.--Arctic Atlantic
Arc.Eur.--Arctic European
Cont.---Continental
Med.----Mediterranean
W.Af.---West African
S.Af.---South African
E.Af.---East African
Kerg.---Kerguelen
Masc.---Mascarene
N.Z.----New Zealand
S.Aus.--South Australian
N.Aus.--North Australian
Ocean.--Oceanic
Jap.----Japanese
Haw.----Hawaiian
Arc.As.--Arctic Asiatic
Arc.Al.--Arctic Alaskan
S.Al.---South Alaskan
Cal.----Californian
Mex.----Mexican
Peru.---Peruvian
Mag.----Magellanic
Ant.----Antarctic

Table #1.

CLAVIDAE.

Species.	Atlantic: Pat.	Atlantic: Braz.	Atlantic: W.I.	Atlantic: E.N.A.	Atlantic: A.Atl.	Atlantic: A.Eur.	Atlantic: Cont.	Atlantic: Med.	Atlantic: W.Af.	Atlantic: S.Af.	Indian: E.Af.	Indian: Kerg.	Indian: Mass.	Pacific: N.Z.	Pacific: S.Aus.	Pacific: N.Aus.	Pacific: Ocean.	Pacific: Jap.	Pacific: Haw.	Pacific: A.As.	Pacific: A.Al.	Pacific: S.Al.	Pacific: Cal.	Pacific: Mex.	Pacific: Peru.	Pacific: Mag.	Antarctic	Bathymetrical in fm.
Ascidioclava:-																												
A.parasitica(Kirkpatrick)														+														0-1
Balella:-																												
B.mirabilis(Nutting)																			+									127
Campaniclava:-																												
C.cleodorae(Gegenbaur)								+																				0-1
Clava:-																												
C.diffusa(Allman)							+																					0-1
C.leptostyla(Agassiz)				+			+															+						0-10
C.nana(Motz-Kossowska)								+																				0-10
C.nodosa(Wright)							+																					0-1
C.squamata(Müller)					+	+	+	+																				0-10
Corydendrium:-																												
C.chevalense(Thorneley)													+															6-8
C.corrugatum(Nutting)																			+									99-319
C.dendriforme(Ritchie)									+																			0-1
C.fruticosum(Fraser)																						+						20-60
C.minor(Nutting)																			+									95-138
C.parasiticum(Cavolini)								+																				0-1
C.sessile(Ritchie)													+															15-20
Endocrypta:-																												
E.huntsmani(Fraser)																						+						5-12
Monobrachium:-																												
M.parasiticum(Mereschkowsky)				+	+	+														+								5-
Rhizogeton:-																												
R.fusiformis(Agassiz)				+																								0-1
R.nudum(Broch)					+	+														+								0-10
Tubiclava:-																												
T.cornucopiae(Norman)							+	+																				15-100
T.fruticosa(Allman)							+							+														0-2
T.lucerna(Allman)							+	+																				0-5
T.pusilla(Motz-Kossowska)								+																				0-20
T.rubra(Farquhar)														+														0-10
Turris:-																												
T.neglecta(Lesson)							+																					0-10
Turritopsis:-																												
T.nutricola(McCrady)			+	+																								0-10

HYDROLARIDAE.

Lar:-																												
L.sabellarum(Gosse)							+																					2-10

Table #1.

CLAVIDAE.

Species	Atlantic	Indian	Pacific
oclava:-			
rasitica(Kirkpatrick)		+	
a:-			
rabilis(Nutting)			+
iclava:-			
eedorae(Gegenbaur)		+	
-			
ffusa(Allman)		+	
ptostyla(Agassiz)	+	+	+
na(Motz-Kossowska)		+	
dosa(Wright)		+	
uamata(Muller)		+ + + +	
drium:-			
evalense(Thornely)			+
rugatum(Nutting)			+
driforme(Hitchie)		+	
ticosum(Fraser)			+
nor(Nutting)			+
rasiticum(Cevolini)		+	
asile(Hitchie)			+
ynta:-			
tsamani(Fraser)			+
ochium:-			
rasiticum(Mereschkowsky)		+ + +	+
eton:-			
siformis(Agassiz)		+	
dum(Broch)		+ +	+
ava:-			
rnucopiae(Norman)		+ +	
uticosa(Allman)		+	+
cerna(Allman)		+ +	
silla(Motz-Kossowska)		+	
bra(Farquhar)			+
:-			
glecta(Lesson)		+	
opsis:-			
tricola(McCrady)		+ +	

HYDROLARIDAE.

bellarum(Gosse)		+	

(almost 1 to 2) and the prevalence of highly differentiated, strictly local forms (5 genera and 12 species), indicate that their distribution is the result of a very early migration. In such a small group, long-continued distribution and differentiation would lead to just such isolation of species as we find here.

The family has for the most part spread out from a center along the shores of Western Europe (indicating the arctic origin), although such unusual forms as Ascidioclava and Endocrypta have undoubtedly developed independently.

2. Corynidae.

A somewhat larger family than the Clavidae, the Corynidae include 16 genera and 61 species, of which 14 genera and 53 species are figured on the accompanying chart. The Corynidae live in shallow water, nearly two-thirds of them being found in Zone I. The medusa-stage is found more predominantly in this family than in the Clavidae, and this may perhaps be a factor in the more cosmopolitan distribution of the Corynidae. The North Atlantic Ocean is again the chief habitat, and there is a good number of arctic species.

The Corynidae are, on the whole, rather attached to rocks and other solid structures than to algae, which are the favorite dwelling-places of the Clavidae. This indicates that they are probably not transported on the structures on which they grow. Again, the largest planula-bearing genus, Coryne, (14 species) is found in only 4 cases outside

Table #2.

CORYNIDAE.

Species.	Atlantic: Brex. Pat.	W.I.	E.N.A.	Arc.Atl.	Arc.Eur.	Cont.	Med.	W.Af.	S.Af.	Indian: E.Af.	Kerg.	Masc.	Pacific: N.Z.	S.Aus.	N.Aus.	Ocean.	Jap.	Haw.	Arc.As.	Arc.Al.	S.Al.	Cal.	Mex.	Peru.	Magel.	Antarctic	Bathymetrical in fm.
Acaulis:-																											
A.primarius(Stimpson)			+	+	+																						5-100
Actinogonium:-																											
A.pusillum(vanBeneden)						+																					* —
Ceratella:-																											
C.crosslandi(Thorneley)										+																	—
C.fusca(Gray)											+			+				+									— 56 —
C.minima(										+																	** Sh. w.
C.procumbens(Carter)									+																		—
Cladocoryne:-																											
C.floccosa(Rotch)			+			+	+																				0-10
C.haddoni(Kirkpatrick)												+															1-20
C.pelagica(Allman)																	+										0-3
C.simplex(Perrier)								+																			floating
Coryne:-																											
C.brachiata(Nutting)																					+						0-10
C.caespes(Allman)							+																				—
C.conferta(Allman)											+																0-20
C.crassa(Fraser)								+													+						1—10
C.dubium(Ritchie)								+																			1-10
C.fruticosa(Hincks)							+																				0-1
C.gigantea(Norman)						+																					—
C.hincksii(Bonnevie)						+																					100
C.longicornis(Bonnevie)						+																					0-10
C.muscoides(Linnaeus)							+	+																			0-20
C.pintneri(Schneider)								+																			11
C.tenella(Farquhar)														+													0-20
C.vanBenedenii(							+	+																			0-100
C.vermicularis(Hincks)				+	+	+																					"deep water"
Denerocoryne:-																											
D.misakinensis(Inaba)																	+										3-33
D.secunda(Inaba)																	+										3-11
Dicoryne:-																											
D.conferta(Alder)			+			+	+	+																			1-200
D.conybearei(Allman)							+	+																			0-20
D.flexuosa(G.O.Sars)	* —																										—
Corynitis:-																											
C.linvillei(Hargitt)				+																							0-20
Gemmaria:-																											
G.costata(Gegenbaur)				+																							1-10
G.gemmosa(McCrady)			+	+														+									0-300
G.implexa(Alder)						+	+																				0-dw.
G.nitida(Hartlaub)																							+	+			—
Halocharis:-																											
H.coronata(Hincks)						+																					1-10
Hydrichthella:-																											
H.epigorgia(Stechow)																		+									0-11
Hydrichthys:-																											
H.boycei(Warren)									+																		on fish
H.mirus(Fewkes)				+																							" "
Hydrocoryne:-																											
H.miurensis(Stechow)																		+									1-10
Syncoryne:-																											
S.densa(Hartlaub)						+																					0-1
S.eximia(Allman)				+	+	+															+	+					0-60
S.ferox(Wright)						+																					0-1
S.frutescens(Allman)						+																					0-1
S.loveni(Sars)					+		+																				0-1
S.mirabilis(Agassiz)				+	+	+	+														+	+	+				0-1
S.pulchella(Allman)						+																					0-1
S.radiata(vonLendenfeld)															+												—
S.reticulata(A.Agassiz)				+																							0-50
S.sarsii(Loven)	+				+	+	+							+													0-30

*Record lacking.

**Shallow water.

the North Atlantic, indicating that medusae probably were a factor in distribution, born by ocean currents.

3. Hydrolaridae.

A single species, Lar sabellarum (Gosse), makes up this distinct family. Lar is a purely local form, and has never been found outside the Western European province. It is a shallow-water form, invariably associated with some species of the sedentary Annelid Sabella, around the mouth of whose tube it grows. It has not been recorded in any depth zone but Zone I.

4. Bougainvillidae.

This family is larger than those already discussed, embracing 16 genera and 95 species, and as one would infer, its distribution is much more widespread; there are only 3 of the 27 provinces in which some representative of the family is not found.

The Bougainvillidae belong mainly to temperate waters, and some of the genera, such as Hydractinia, attain their greatest development in polar waters. The two regions in which these hydroids are most abundant are the Arctic-European,-Continental-Mediterranean group of provinces and the Eastern North American. Next in order come the Arctic Atlantic and the Californian. The European provinces have 2 of the Californian species, 4 of the Eastern North American species, and 9 of the Arctic Atlantic species. All the species

the North Atlantic, indicating that medusae probably were a factor in distribution, born by ocean currents.

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4. Bougainvillidae.

This family is larger than those already discussed, embracing 16 genera and 98 species, and as one would infer, its distribution is much more widespread; there are only 3 of the 27 provinces in which some representative of the family is not found.

The Bougainvillidae belong mainly to temperate waters, and some of the genera, such as Hydractinia, attain their greatest development in polar waters. The two ~~provinces~~ regions in which these hydroids are most abundant are the Arctic-European,-Continental-Mediterranean group of provinces and the Eastern North American. Next in order come the Arctic Atlantic and the Californian. The European provinces have 2 of the Californian species, 4 of the Eastern North American species, and 9 of the Arctic Atlantic species. All the species

Table #3.

BOUGAINVILLIDAE.

Species	Atlantic.								Indon.			Pacific									Antarctic	Bathymetrical in fm.
	Brax Pat.	W.I.	E.U.S.	Arcath.	Arctic	Cont.	Med.	W.Af.	S.Af.	E.Af.	Terra	Masc.	N.Z.	S.Aus.	N.Aus.	Japan	Haw.	Arc.Ak.	Arc.Al.	S.Al.	Col.	Mex.	Peru	Mag.		
Bimeria:-																										
B.annulata(Nutting)																				+	+					0-42
B.arborea(Browne)						+																				412
B.biscayana(Browne)						+																				412
B.brevis(Fraser)			+																							0-1
B.fragilis(Stechow)							+																			0-1
B.franciscana(Torrey)																					+					0-1
B.gracilis(Clarke)																					+					0-1
B.groenlandica(Levinsen)			+	+																+						10-60
B.humilis(Allman)		+				+																				0-10
B.nutans(Wright)						+	+													+	+					0-1
B.robusta(Torrey)																					+					0-1
B.vestita(Wright)						+																	+			0-1
Bougainvillia:-																										
B.carolinensis(McCrady)			+																							0-10
B.glorietta(Torrey)																					+					?0-20
B.longicirra(Stechow)		+																								0-1
B.mertensi(A.Agassiz)																			+		+					?0-20
B.ramosa(vanBeneden)		+				+	+									++										0-80
B.rugosa(Clarke)		++																								0-5
B.superciliaris(Agassiz)			++																							0-10
B.vanBenedenii(Bonnevie)				+	+	+																				0-2
Calyptospadix:-																										
C.cerulea(Clarke)			+																							0-10
Cionistes:-																										
C.reticulata(Wright)						+																				1-10
Clathrozoon:-																										
C.wilsoni(Spencer)														+												—
Clavactinia:-																										
C.gallensis(Thorneley)												+														2
Clavopsella:-																										
C.weismanni(Hargitt)							+																			0-10
Corynopsis:-																										
C.alderi(Hodge)						+																				"deep water"
Hydractinia:-																										
H.aggregata(Fraser)																				+						?0-20
H.allmani(Bonnevie)						+	+												+	+						1-650
H.angusta(Hartlaub)																									+	150-200
H.antarctica(Studer)											+															—
H.borealis(Mereschkowsky)	—																									—
H.calcarea(Carter)								+																		0-10
H.californica(Torrey)																					+					—
H.carica(Bergh)						+												+								7-16
H.carolinae(Fraser)			+																							13-14
H.dentritica(Hickson&Gr.)																									+	0-10
H.echinata(Fleming)			+	+	+	+	+																			0-100
H.epiconcha(Stechow)																+	+									-81-
H.fucicola(Sars)				?+	?+	+																				0-1
H.humilis(Bonnevie)					+																					0-10
H.millerii(Torrey)																					+					0-1
H.minuta(Bonnevie)					+																					60
H.ornata(Bonnevie)				+	+	+																				135-165
H.pacifica(Hartlaub)																							+			10
H.parvispina(Hartlaub)																							++			-3-
H.provuti(Motz-K.)							+																			—
H.sarsii(Allman)					+																					0-10
H.sodalis(Stimpson)																+										4-100
H.spiralis(Goto)																+										0-5
H.verdi(Ritchie)								+																		6
Hydrodendrium:-																										
H.gorgionidea(Nutting)																	+									2
Keratosum:-																										
K.complexum(Hargitt)			+																							5-15
Parawrightia:-																										
P.robusta(Warren)								+																		—

Species.	Atlantic: Pat.	Braz.	W.I.	E.N.A.	Arc.Atl.	Arc.Eur.	Cont.	Med.	W.Af.	S.Af.	Indian: E.Af.	Masc.	Rerg.	Pacific: W.Aus.	S.Aus.	N.Aus.	Jap.	Ocean.	Haw.	Arc.As.	Arc.Al.	S.Al.	Col.	Mex.	Peru.	Mag.	Antarctic	Bathymetrical In fm.
Perigonimus:-																												
P.abyssi(G.O.Sars)						+																						80-200
P.antarcticus(Hartlaub)																											+	0-130
P.belgicae(Vanhoffen)	—																											—
P.bitentaculatus(Wright)							+																					?0-20
P.cidaritis(Weismann)								+																				?0-20
P.cirratus(Hartlaub)	—																											—
P.coccineus(Wright)							+																					0-1
P.corii(Hadzi)	—																											—
P.decorans(Schneider)								+																				0-10
P.formosus(Fewkes)																							+					—
P.gelatinosus(Duerden)							+																					37-50
P.georginae(Hadzi)	—																											—
P.inflatus(Duerden)							+																					43-57
P.jonesi(Osborn&Hargitt)				+																								0-20
P.linearis(Alder)							+																					d.-w.
P.mineatus(Wright)							+																					0-1
P.multicornis(Allman)							+																					—
P.muscoides(Sars)						+																						50-60
P.nanellus(Stechow)								+																				?0-20
P.neapolitanus(Weismann)								+																				?0-20
P.nudus(Stechow)								+																				?0-20
P.palliatus(Wright)							+																					?0-20
P.pugetensis(Heath)																							+					on fish
P.quadritentaculatus(Wright)							+																					?0-20
P.repens(Wright)	+					+	+	+	+			+						+					++		++			1-325
P.roseus(Sars)						++																						20-54
P.schneideri(Motz-K.)								+																				54-70
P.serpens(Allman)							+	+																				2-12
P.sessilis(Wright)							+	+																				0-q.w.
P.steinachi(Jickeli)	—																											—
P.sulfureus(Chun)									+																			—
P.vagans(Thorneley)											+																	10-12
P.vestitus(Allman)							+																					0-1
P.yoldiaé-arcticae(Birula)						++																						220
Podocoryne:-																												
P.aculeata(Wagner)							++																					0-1
P.anechinata(Ritchie)								+																				5
P.areolata(Alder)							+																					30
P.carnea(Sars)				+	+	+	+	+	+	+																+		0-200
P.denhami(Thorneley)												+																—
P.fulgurans(Agassiz)				++																								—
P.minoi(Alcock)												+						+++										on fish.
P.proboscidea(Hincks)								+																				0-1
Provutella:-																												
P.grisea(Motz-Kossowska)									+																			0-43
Stylactis:-																												
S.halecii(Ritchie)																											+	1-20
S.hooperi(Sigerfoos)					+																							0-10
S.inermis(Allman)									+																			0-1
S.vermicola(Allman)																		+										2900
S.arctica(Jaderholm)						+																						1083

| | | |

found in other parts of the world are scattered, no more than 5 being found in any one province. The large majority of these species are either found also in the North Atlantic or are local. There is, however, a subsidiary group in the Pacific, centering at present in the Japanese and Oceanic provinces, and having sufficient affinity with polar forms to warrant the belief that this group, like the North Atlantic group, is arctic in origin, having been carried south by the Kamschatka Current through the Bering Sea. Representatives from the Mascarene, Oceanic, Japanese, Arctic Asiatic, Alaskan, and Californian provinces migrated from the north in this way. Practically all other provinces have local or North Atlantic species.

Regarding their distribution in depth, it is largely confined to Zone I, although there is a good representation in the next four zones, and even one specimen, dredged by the "Challenger" in Zone X, at 2900 fathoms (Stylactis vermicola.)

These facts point to certain conclusions for the family:- a) The Bougainvillidae, along with the Clavidae and Corynidae, were among the first to migrate down from the north polar regions, and this migration was at a sufficiently early date to have permitted fairly complete separation into Atlantic and Pacific groups. b) The Kamschatka Current and the Japan Stream have mingled the Oceanic and Alaskan-Californian faunas. c) Distinct faunas inhabit both sides of the North Atlantic, linked by common arctic species. d) The few remaining

holarctic species are remnants of the ancestors of these three families. e) The Bougainvillidae have penetrated into deeper waters than the preceding families, mainly because of a longer period of migration.

5. Pennaridae.

The Pennaridae are a small family, of 6 genera and 12 established species. They are found exclusively within Zone I, and are most abundant in the Continental-Mediterranean area. The most important genus, Pennaria, however, has its present headquarters in the West Indies, but is the only representative of the family found in that province. The most cosmopolitan species is Pennaria cavolini(Ehrenberg). Beside P. cavolini, the only species found outside the North Atlantic Ocean is P. symmetrica, recorded from the West Indies and East Africa. This unusual distribution is probably the result of transportation by ships, since there is no possible connection by means of ocean currents.

The Pennaridae are the only family, except the Hydrolaridae, the great majority of whose members produce free medusae. This condition is practically universal in the family, but when we realize that 6 of the 12 species are local---i.e.found in only one province---and that 4 of the remainder are found only in 2 contiguous provinces, we see at once that the medusae have been of small value in aiding the distribution of the family as a whole.

There is but one representative of the family in the

PENNARIDAE.

Eastern North American province; therefore the original migration was probably down the east side of the Atlantic and thence to the West Indies.

6. Eudendridae.

This family includes the single genus Eudendrium, of 39 species. Reproduction is universally by planulae from fixed sporosacs.

Geographically, Eudendrium is a widespread genus; only the Brazilian, Mexican, and New Zealand provinces are without some representative, and the first two of these have so far yielded very few hydroids of any sort.

Practically equal in importance as centers for this genus are the two sides of the North Atlantic Ocean and the Mediterranean. The west coast of North America is a region of secondary importance. The species of Eastern North America and Western Europe include a number common to both, usually arctic forms.

Outside these provinces, most of the provinces are directly related to the North Atlantic center by species common to both. In the Mascarene, however, only one of the 6 species is found in the North Atlantic, and that is from the West Indies; but in spite of this, we must believe that the Mascarene was populated from the north; independent bipolar development within a single genus is inconcievable. Since ocean currents are adverse toward a migration south and east from the North Atlantic, this province must have

2. Rudbeckiidae.

This family includes the single genus Rudbeckia, of 39 species. Reproduction is universally by plumules from fixed sporocarps.

Geographically, Rudbeckia is a widespread genus; only the Brazilian, Mexican, and New Zealand provinces are without some representative, and the first two of these have so far yielded very few hydroids of any sort.

Practically equal in importance as centers for this genus are the two sides of the North Atlantic Ocean and the Mediterranean. The west coast of North America is a region of secondary importance. The species of Eastern North America and Western Europe include a number common to both, usually arctic forms.

Outside these provinces, most of the provinces are directly related to the North Atlantic center by species common to both. In the Hesperians, however, only one of the 6 species is found in the North Atlantic, and that is from the West Indies; but in spite of this, we must believe that the Hesperian was populated from the north; independent bi-polar development within a single genus is inconceivable. Since ocean currents are adverse toward a migration south and east from the North Atlantic, this province must have

EUDENDRIDAE.

Species.	Atlantic								Indian		Pacific										Antarctic	Bathymetrical in fm.
	Brax. Pat.	W.I.	E.N.A.	Arc.Atl.	Arc.Eur.	Cont.	Med.	W.Af.	S.Af.	E.Af.	Trop.	Masc.	N.Z.	S.Aus.	N.Aus.	Ocean	Jap.	Haw.	Arc.As.	Arc.Al.	S.Al.	Cal.	Mex.	Peru.	Mag.		
Eudendrium:-																										
E.album(Nutting)			+			+																				0-39
E.annulatum(Norman)			+	+	+	+		+																		0-25
E.arbusculum(Wright)						+	+																	+	+	10-30
E.armatum(Tichomiroff)	—																									—
E.armstrongi(Stechow)												+					+									9-433
E.attenuatum(Allman)		+										+														3-60
E.calceolatum(Motz-K.)							+																			0-10
E.californicum(Torrey)																					+	+				0-1
E.capillare(Alder)			+	+	+	+	+	+				+				+	+	+	+		+	+			+	1-134
E.caricum(Jäderholm)																			+							0-10
E.carneum(Clarke)			+																							0-10
E.cingulatum(Stimpson)			+																							20
E.cnidoferum(Jäderholm)					+																					—
E.cochleatum(Allman)			+																							-6-
E.deforme(Hartlaub)																								+		0-10
E.dispar(Agassiz)			+				+																			0-20
E.distichum(Clarke)		+																								—
E.eximium(Allman)		+																								98
E.fragile(Motz-K.)							+																			0-20
E.fruticosum(Allman)		+																								135
E.generalis(vonLend.)												+		+	+											3-20
E.gracile(Allman)		+																								3-4
E.griffini(Light)																+										—
E.hargitti(Congdon)		+																								—
E.insigne(Hincks)						+	+														+				+	0-20
E.laxum(Allman)		+																								100
E.maldivense(Borradaile)												+														22-30
E.novae-zelandiae(Marktanner)													+													—
E.parvum(Warren)									+			+														?0-20
E.planum(Bonnevie)					+																					—
E.pusillum(vonLendenfeld)												+			+											0-9
E.pygmaeum(Clarke)																				+						?0-20
E.racemosum(Cavolini)							+										+									0-80
E.ramaeum(Pallas)			+	+	+	+	+	+				+					+	+	+		+	+		+		0-255
E.ramosum(Linnaeus)		+	+	+	+	+	+	+		+							+				+	+		+	+	0-542
E.simplex(Pieper)							+																			0-10
E.stratum(Bonnevie)					+																					—
E.tenellum(Allman)		+	+	+	+	+															+					8-471
E.tenue(A.Agassiz)			+																							1-10
E.vaginatum(Allman)			+			+	+										+				+					0-?
E.vestitum(Allman)																+										75

received its forms from the North Pacific; this view is upheld by the fact that 3 of the 6 species are found in the Pacific.

In depth, Eudendrium shows a marked preference for Zone I; there is a steady decrease in numbers below 20 fathoms.

All facts point toward a somewhat more recent migration of this genus, only from the north, and early enough to have allowed migration into the Mascarene and Antarctic regions. There is a much closer connection between the faunas of the same latitude in different seas than we have heretofore observed.

7. Tubularidae.

The family Tubularidae formerly embraced all the Gymnoblastea, but as now outlined it includes but 11 genera and 62 species. The principal genus is Tubularia, of 35 species.

If it were not for the cosmopolitan distribution of Tubularia, the family would be practically limited to the North Atlantic Ocean, for of the other 10 genera, only 13 species are found within that area. As it is, the Eastern North American and Arctic European provinces lead in number of species (14 and 15 respectively); the Continental is third, with 11. No other province has over 6.

Considering the North Atlantic group of provinces as a center for this family, we find that outside this area most of the forms are local, except for a few common also to the North

TUBULARIDAE.

Species.	Atlantic: Brazil. Pat.	W.I.	E.N.A.	Arc.Atl.	Arc.&Ant. Cont.	Med.	W.Af.	S.Af.	Indian: E.Af.	Trop.	Mase.	Pacific: N.Z.	S.Aus.	N.Aus.	Oceon.	Jap.	Haw. Is.	Arc.As.	Arc.Al.	S.A.	Cal.	Mex.	Peru.	Magp.	Antarctic	Bathymetrical infm.
Amalthea:-																										
A.islandica(Allman)				+																						98
A.januarii(Steenstrupp)	+																									—
A.sarsii(Steenstrupp)					+																					10-50
A.uvifera(Schmidt)					+																					2-10
Branchiocerianthus:-																										
B.imperator(Allman)									+		+					+				+						2-2600
B.urceolatus(Mark)																						+				208-280
Corymorpha:-																										
C.antarctica(Pfeffer)	+																									0-1
C.carnea(Clarke)																+			+							70-81
C.groenlandica(Allman)				+																						—
C.nana(Alder)					+																					0-126
C.nutans(Sars)				+	+	+																				2-50
C.palma(Torrey)																					+					0-1
C.pendula(Agassiz)			+																							4-25
C.tomoënsis(Ikeda)																+										—
Ectopleura:-																										
E.ochracea(Agassiz)			+		+																					0-10
E.pacifica(Thorneley)															+											0-10
E.prolifica(Hargitt)			+																							1-10
Gymnogonos:-																										
G.crassicornis(Bonnevie)					+																					217
Hybocodon:-																										
H.chilensis(Hartlaub)																							+			—
H.prolifer(Agassiz)			+		+																					0-217
Hypolytus:-																										
H.peregrinus(Murbach)			+																							0-10
Lampra:-																										
L.arctica(Jaderholm)					+																					—
L.atlantica(Bonnevie)					+																					1203
L.microrhiza(Hickson&Gr.)																									+	300
L.parvula(Hickson&Gravely)																									+	10-20
L.purpura(Bonnevie)					+																					448
L.socia(Swenander)					+																					—
Nemopsis:-																										
N.gibbesii(McCrady)		+																								Floating?
Pelagohydra:-																										
P.mirabilis(Dendy)												+														Free-swimming?
Tubularia:-																										
T.aspera(Allman)																							+			—
T.asymmetrica(Bonnevie)					+																					—
T.attenoides(Coughtrey)												+														0-10
T.attenuata(Allman)						+																				15-50
T.bellis(Allman)						+																				0-2
T.borealis(Clarke)																			+							0-1
T.calamaris(vanBeneden)			+			+																				2-50
T.cornucopiae(Bonnevie)					+	+																				100-1321
T.couthouyi(Agassiz)				+																						2-19
T.cristata(McCrady)			+				+																			0-1
T.crocea(Agassiz)			+			+					+									++		+				0-25
T.formosa(Hartlaub)																							+			—
T.gracilis(vonLendenfeld)											+		++													0-10
T.harrimani(Nutting)																				+						20-20
T.hodgsoni(Hickson&Gr.)																									+	130
T.humilis(Allman)						+	+																			0-2
T.indivisa(Linnaeus)	+	+	+	+	+	+	+												++							0-200
T.insignis(Allman)						+																				—
T.kerguelenensis(Studer)										+																—
T.larynx(Ellis&Solander)			+	+	+	+	+													+						0-50
T.longstaffi(Hickson&Gr.)																									+	124
T.marina(Torrey)																					+					0-1
T.mesembryanthemum(All.)						+										+										0-10
T.pacifica(Allman)											+										+					—37
T.parasitica(Hargitt)			+																							4-25
T.polycarpa(Allman)																							+			—
T.pygmaea(Lamouroux)													+													—
T.ralphi(Bale)													++												+	0-20
T.regalis(Boeck)				+	+														+							117-190
T.simplex(Alder)					+	+																				1-200
T.sclitaria(Warren)							+	+																		0-1
T.spectabilis(Agassiz)			+																							0-10
T.tenella(Agassiz)			+																							6-10
T.tubularoides(A.Agassiz)																					+					—

North Atlantic, notably holarctic forms.

A record of the bathymetrical distribution of 60 species of the Tubularidae (1 is free-swimming, 1 was found afloat) shows that again the family is most abundant in Zone I, the number in deeper zones steadily decreasing.

The Tubularidae, then, have migrated out from a center in the North Atlantic, and are a shallow-water family. Medusae are of little or no importance in distribution, since the genus Tubularia produces no medusae.

8. Halecidae.

The Halecidae form the connection between the Gymnoblastea and the Calyptoblastea, or hydroids proficed with a polyp-cup or hydrotheca, by reason of their partially developed hydrotheca. In mode of life and other habits they do not differ from the other hydroid families.

The South Alaskan province leads in number of species, with the Continental-Mediterranean area second and the east coast of North America third.

The family includes 6 genera and 66 species. 55 of these are species of the genus Halecium, whose distribution as one of the major hydroid genera will first be outlined.

The provinces having the largest numbers of species of Halecium are:- South Alaskan (20); Continental (13); Eastern North American (11); Mediterranean (12); Arctic European(11); Arctic Atlantic (9).. As in some of the preceding families,

Table #7.

HALECIDAE.

Species	Atlantic: Brez. Pat.	W.I.	E.N.A.	Arc.Atl.	Arc.Eur.	Cont.	Med.	N.Af.	S.Af.	Indian: E.Af.	Merg.	Mosc.	Pacific: N.Z.	S.Aus.	N.Aus.	Ocean.	Jap.	Kom.	Arc.As.	Arc.Al.	S.Al.	Sal.	Mex.	Peru.	Mag.	Antarctic	Bathymetrical in ft.
Campalecium:-																											
C.medusiferum(Torrey)																						+					6
Halecium:-																											
H.annulatum(Stechow)							+																				—
H.annulatum(Torrey)																					+	+	+				9-10
H.argenteum(Clarke)																							+				458
H.articulosum(Clarke)			+			+															?+						0-20
H.balei(Fraser)													+	+	+						+		+				-66
H.beani(Johnston)	+		+	+	+	+	+	+						+			+				+					+	29-249
H.bermudense(Congdon)		+	+																								0-10
H.capillare(Pourtalés)		+																									90-100
H.conicum(Stechow)							+																				3-4
H.crinis(Stechow)																	+										?0-1
H.curvicaule(Lorenz)			+	+	+	+													+		?+						3-309
H.cymiforme(Allman)	+																+										0-9
H.delicatulum(Coughtrey)									+				+				+								+		7-185
H.densum(Calkins)																					+						0-1
H.dichotomum(Allman)									+																		0-10
H.fastigiatum(Allman)									+																		110
H.filicula(Allman)			+			+																					140-222
H.geniculatum(Nutting)						+															+						—
H.gorgonoïde(G.O.Sars)					+																						80-100
H.gracile(Verrill)			+																				+				-66
H.groenlandicum(Kramp)				+	+																						17-112
H.halecinum(Linnaeus)			+	+	+	+	+		+												+						2-50
H.interpolatum(Ritchie)	+																										0-1
H.kofoidi(Torrey)																					+	+	+				6-42
H.labrosum(Alder)			+	+	+	+	+												+								35-100
H.lamouroux**x**ianum(d'Orbigny)	+																										"on beach"
H.lankesteri(Bourne)	—																										—
H.macrocephalum(Allman)			+																								120
H.mediterraneum(Weismann)							+																				3-4
H.minutum(Broch)				+	+	+													+	+							22-158
H.muricatum(Ellis&Solander)				+	+	+	+	+	+			+							+		+						3-50
H.mutilum(Allman)											+																—
H.nanum(Alder)			+	+			+	+																			?0-10
H.nuttingi(Torrey)																					+	+					15-25
H.ornatum(Nutting)																					+						—
H.patagonicum(d'Orbigny)	+																										0-10
H.petrosum(Stechow)	—																										—
H.plumosum (Hincks)							+																				—
H.pusillum(Sars)					?+		+																				0-2
H.pygmaeum(Fraser)																					+						?0-20
H.reflexum(Stechow)							+	+				+															0-1
H.reversum(Nutting)																					+						?0-20
H.robustum(Nutting)																					+						—
H.robustum(Pieper)							+																				0-10
H.scandens(Nutting)																		+									59
H.scutum(Clarke)						+															+						0-25
H.sessile(Norman)						+	+		+								+										0-222
H.simplex(Pictet)												+				+											15-20
H.speciosum(Nutting)																					+						—
H.tehuelcha(d'Orbigny)	+																										"beach"
H.telescopicum(Allman)						+								+													15-98
H.tenellum(Hincks)			+	+	+	+	+	+	+			+	+	+					+		+	+		+	+		0-205
H.textum(Kramp)					+																						80-170
H.washingtoni(Nutting)																					+	+					?0-20
H.wilsoni(Calkins)																					+						0-2
Hemitheca:-																											
H.intermedia(Hilgendorf)													+														0-10
Hydranthea:-																											
H.australis(Thorneley)																+											0-40
H.margarica(Hincks)																											7-10
Ophiodissa:-																											
O.arborea(Allman)											+						+									+	38-98
O.australis(Bale)														+													—
O.caciniformis(Ritchie)									+																		10
O.carchesium(Fraser)																					+						50
O.dichotomum(																+											6-7
O.mirabilis(Hincks)							++																				0-8
Phylactotheca:-																											
P.pacifica(Stechow)																+											0-10

Halecium has thus obviously arisen in the arctic regions, leaving at the present time a large number of arctic and holarctic forms, and it has not only migrated south along the shores of the Atlantic, but through the Bering Sea into the Pacific as well, developing a number of distinct Pacific species. There is, however, much connection between Atlantic and Pacific groups. Of the 20 South Alaskan species, 6 are found in the Eastern North American, 5 in the Arctic Atlantic, 6 in the Arctic European, 7 in the Continental, and 4 in the Mediterranean, so the fact of meridional migration from a common arctic source seems well established.

All the provinces bordering on the Atlantic Ocean, the Mascarene, and the Antarctic contain, with one or two exceptions, either local species or those found also in the North Atlantic Ocean. The provinces of the Pacific, with the exception of 2 or 3 cosmopolitan species, have in them species found only in the Pacific.

In depth, Halecium is found mostly in Zone I, with a considerable number of species in Zones II, III, and IV. There is a larger proportion in the deeper zones than we have found in the families already discussed.

The other five genera of the Halecidae, including 11 species, are scattered, no more than two being found in any one province. They do not affect the general plan of distribution in any way. It is an interesting fact that out of 14 provinces in which one or two of these species have been found, only 5 are north of Africa or Japan. These genera

are thus doubtless descended from Halecium, during the course of their migration. The great distance from the source of the family and the changed environment in which they now live support this belief.

By way of conclusion for the family, we may state:- a) From a common arctic source two groups of Halecidae have developed, one in the Atlantic and one in the Pacific, the two linked by forms common to both; b) due to the greater number of species living in zones of greater depth, the action of currents, which are the principal factors in distribution, has been lessened, resulting in fewer species within and south of the tropics; c) the species which have penetrated south of the tropics are for the most part differentiated into separate genera; d) only those species which live in Zone I are cosmopolitan.

9. Campanulinidae.

The Campanulinidae constitute a small family, of 9 genera and 33 species. They are, like the other families, of arctic origin, and are at present very seldom found south of the Tropic of Cancer. The north and west coasts of Europe lead in numbers of species, with the Eastern North American next in order.

The predominance of arctic and holarctic species in this family leads us to suspect a greater uniformity of species in all temperate waters, and this is shown to be the case. The provinces bouding the North Atlantic are

Table #8.

CAMPANULINIDAE.

Species.	Atlantic										Indian			Pacific										Antarctic	Bathymetrical in fms.
	Braz. Pat.	W.I.	E.N.A.	Arc.Atl.	Arc.Eur.	Cont.	Med.	W.Af.	S.Af.	E.Af.	Red Sea	Mosc.	N.Z.	S.Aus.	W.Aus.	Ocean.	Jap.	Haw.	Arc.As.	Arc.Al.	S.Al.	Cal.	Mex.	Peru.	Mob.		
Calycella:-																									
C.oligista(Ritchie)												+													8-20
C.parkeri(Hilgendorf)													+												0-16
C.syringa(Linnaeus)			+	+	+	+	+			+								+	+	+		+	+		+	2-245
Campanulina:-																									
C.acuminata(Alder)						+																			?0-50
C.belgicae(Hartlaub)																									+ 210-250
C.ceylonensis(Browne)												+													0-10
C.chilensis(Hartlaub)																		+					+		+ 9-50
C.denticulata(Clarke)																		+					+		0-2845
C.forskålea(Péron&Lesueur)						+															+				0-20
C.germanica(Hartlaub)						+																			—
C.panicula(G.O.Sars)					+	+																			50-220
C.repens(Allman)						+																			5
C.rugosa(Nutting)																					+				?0-20
Lafoeina:-																									
L.longitheca(Jäderholm)																									+ 5-20
L.maxima(Levinsen)				+	+														+						7-70
L.tenuis(G.O.Sars)				+	+	+																			16-300
Lovenella:-																									
L.clausa(Lovén)			+			+																			10-
L.corrugata(Thorneley)											+														20
L.grandis(Nutting)			+																						?0-20
L.producta(Sars)				+	+	+															+				80-200
Opercularella:-																									
O.hispida(Nutting)						+						+						+							1-10
O.lacerata(Johnston)			+	+	+	+	+							+				+							0-26
O.longicauda(Nutting)																			+						138
O.pumila(Clarke)			+																						1-30
Stegopoma:-																									
S.fastigiatum(Alder)			+	+	+	+												+	+	+					106-651
S.plicatile(Sars)				+	+	+	+											+	+						0-213
Tetrapoma:-																									
T.quadridentatum(Hincks)				+	+	+												+	+		+				16-158
Zygodactyla:-																									
Z.crassa(Agassiz)	—																								—
Z.groenlandica(Péron&Les.)				+	+																				—

all closely connected by common species, and the Mediterranean and South African forms belong wholly to the North Atlantic fauna. In the Pacific, the majority of the species in the Japanese, Hawaiian, Arctic Asiatic, and Alaskan provinces belong also to the North Atlantic. The 2 Mascarene species are undoubtedly migrants from the Pacific. Three of the four Antarctic forms are identical with northern species.

The family is most abundant in Zone I, but the proportion found in the next four zones is slightly greater than that of the Halecidae. Of the 5 most cosmopolitan species, all but one are found in Zone I.

The Campanulinidae are an arctic family whose migration has not been made necessary by an adverse environment, and whose distribution has presumably been somewhat retarded by a tendency to grow in deeper water. The family thrives best in cold water, and is undoubtedly one of the groups which was not forced into warmer waters during the Pleistocene; its present distribution is simply the result of condition which have acted alike on all the hydroid families.

10. Lafoeidae.

The Lafoeidae include 11 genera and 74 species, of which the principal genus is Lafoea, of 20 species.

Throughout the family, there are North Atlantic and North Pacific groups, but these are for the most part identical. For example, 5 of the 6 species of Lafoea found in

Species.	Atlantic								Indian		Pacific									Antarctic	Bathymetrical fm.
	Braz. Pat.	W.I.	E.N.A.	Arc.Atl.	Arc.Eur.	Cont.	Med.	W.Af.	S.Af.	E.Afr.	Ter.	Masc.	S.Aus.	N.Aus.	Ocean	Jap.	Ham.	Arc.As.	Arc.Al.	S.Al.	Cal.	Mex.	Peru	Mag.		
Bonneviella:-																										
B.grandis(Allman)				+	+											+										105-800
B.ingens(Nutting)																+										229
B.regia(Nutting)																+			+	+						43-229
B.superba(Nutting)																			+							283
Cryptolaria:-																										
C.abies(Allman)		+																								-
C.abyssicola(Allman)															+	+										-7600-
C.diffusa(Allman)								+																		-2500-
C.elegans(Allman)		+																								152
C.flabellum(Allman)		+																								390
C.geniculata(Allman)																+										315
C.humilis(Allman)						+																				1000
C.operculata(Nutting)																	+									138
C.pulchella(Allman)																+	+					+				18-458
C.symmetrica(Nutting)																+	+									13-225
C.triserialis(Fraser)				+																						20
Grammaria:-																										
G.abietina(Sars)				+	+	+	+											+		+						
G.borealis(Levinsen)					+	+																				5-142
G.gracilis(Stimpson)				+																						-81-
G.immersa(Nutting)					+																					-
G.insignis(Allman)																+	+	+	+							16-190
G.magellanica(Allman)	+															+										50-75
G.scandens(Stechow)																						+	+	+		-70-
G.serpens(Hassall)		+	+	+	+	+	+	+								+										0-10
G.stentor(Allman)	+										+						+	+	+				+	+	+	12-800
Halisiphonia:-																								+		28-60
H.megalotheca(Allman)															+											2600
Hebella:-																										
H.brochi(Hadzi)							+																			-
H.calcarata(A.Agassiz)		+	+			+		+		+		+	+	+	+	+	+	+								0-122
H.corrugata(Thorneley)								+		+		+					+									0-10
H.crateroides(Ritchie)												+														5-270
H.gigas(Pieper)							+																			0-1
H.neglecta(Stechow)												+					+									-49-
H.parasitica(Ciamician)							+										+									0-1
H.pocillum(Hincks)			+	+	+	+												+	+	+						15-51
H.pygmaeum(Hincks)			+																							-24-
H.scandens(Bale)									+				+	+	+	+										-26-
H.striata(Allman)	+																							+	+	8-15
Lafoea:-																										
L.adhaerens(Nutting)																			+							-
L.antarctica(Hartlaub)																									+	-
L.coalescens(Allman)		+																								140
L.conferta(Allman)						+		+		+					+							+			+	70-750
L.convallaria(Allman)		+																				+				45-177
L.dispolians(Warren)									+																	-
L.dumosa(Fleming)		+	+	+	+	+	+	+				+					+	+	+					+		30-450
L.elongata(Armstrong)												+														0-1
L.expansa(Levinsen)			+	+		+													+							-33-
L.fruticosa(Sars)		+	+	+	+	+	+	+				+					+		+			+	+			12-450
L.gigantea(Bonnevie)	—																									—
L.gracilis(Allman)								+				+														250-700
L.gracillima(Alder)		+	+	+	+	+						+	+					+		+	+			+	+	6-256
L.grandis(Hincks)			+	+	+	+		+											+	+						100-100
L.parvula(Hincks)						+																				19-23
L.plicata(Hartlaub)																									+	254
L.quadridentata(Hincks)				+																						15-20
L.serrata(Clarke)		+	·			+		+		+		+										+	+			4-292
L.symmetrica(Bonnevie)			+			+		+																		25-776
L.venusta(Allman)		+										+														-324-
Lictorella:-																										
L.antipathes(Lamouroux)																+										3-6
L.carolina(Fraser)																			+							9-50
L.cervicornis(Nutting)																	+									188
L.cyathifera(Allman)																+										63-130
L.flexilis(Pictet&Bedot)							+																			172
L.geniculata(Clarke)																						+				458
L.operculata(Hartlaub)																							+	+		-2444-
L.pinnata(G.O.Sars)			+	+	+	+						+				+	+	+								20-463
Scandia:-																										
S.mutabilis(Ritchie)		+	+					+	+			+														41fm —
Toichopoma:-																										
T.obliquum(Hincks)				+	+																					11-103
Trichydra:-																										
T.pudica(Wright)						+																				?0-20
Zygophylax:-																										
Z.biarmata(Billard)							+	+								+									+	60-222
Z.curvitheca(Stechow)																+										325
Z.exserta(Johnson)			+				+						+			+						+				38-700
Z.operculata(Jäderholm)												+					+									-160-
Z.profunda(Quelch)								+																		500
Z.tizardensis(Kirkpatrick)																+										35-98

the South Alaskan are European as well. This is true to a somewhat lesser extent in the other genera.

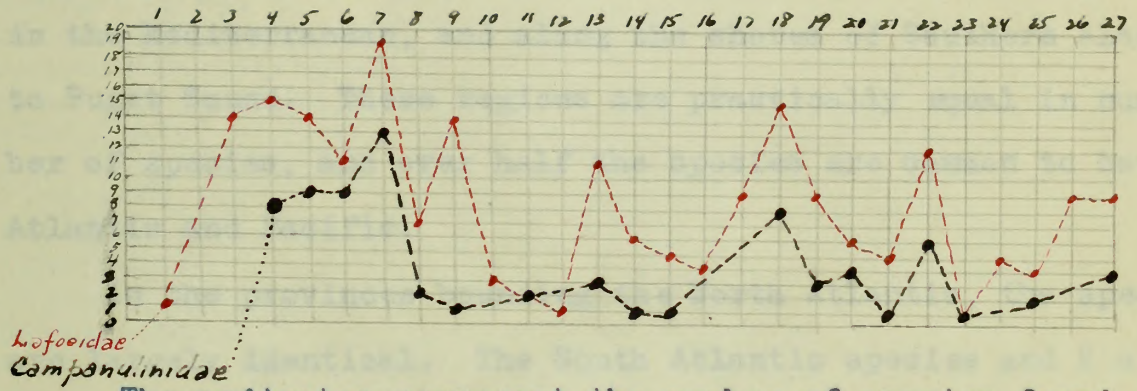
The family as a whole are quite uniformly distributed, but the forms found south of the equator are in almost every case found north of it as well, and are referable to either the Pacific or the Atlantic group, or both. Even in the Antarctic, 4 of the 9 species are found also in the north. This uniform distribution makes for a large number of cosmopolitan species, in which the Lafoeidae are rich.

Different genera have developed in some cases in the different oceans. While Lafoea centers mainly in the Atlantic, Hebella, Zygophylax, and Bonneviella are decidedly of the Pacific fauna; Grammaria is about equally divided. The minor genera are scattered.

In depth, there is practically an equal percentage of the Lafoeidae in all of the first five zones---down to 500 fathoms---with the greatest number between 100 and 200 fathoms. Hebella is the only genus found most abundantly in Zones I and II.

At first glance, the distribution of the Lafoeidae appears to be much wider than that of the Campanulinidae and Halecidae, and, in view of what has been said regarding the influence of a deep-water habitat on distribution, it may be difficult to see why the Lafoeidae, so decidedly a deep-water group, should be apparently more cosmopolitan in their range than the Campanulinidae. But a comparison of the two by means of the accompanying graph shows that

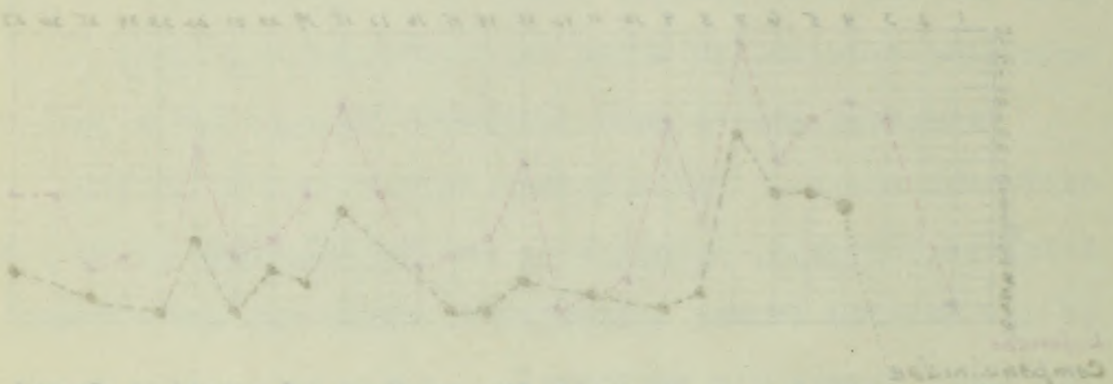
the Lafoeidae are no more cosmopolitan than the Campanulinidae in proportion to their numbers. The curve of one keeps at a fairly constant distance above that of the other, which, considering the greater numbers of Lafoeidae involved, proves that the distribution of this family is no more widespread than would be expected, and that the influence of the deep-water mode of life in retarding normal distribution still holds good.



The ordinates represent the number of species found in each region and the abscissas the 27 provinces, in the same order as in the distribution charts.

The Lafoeidae, then, are an arctic deep-water family, migrating like the foregoing families from a common arctic source. In some of the genera, the spread has taken place mainly through the Atlantic, in others through the Pacific. Like the Campanulinidae, the family was not forced out of the north by the cold during the Pleistocene, and its present distribution is the result of natural agencies which have worked alike on all hydroid families.

The family has not yet become "acclimatized" to tropical waters, and this is also true of the Campanulinidae.



11. Campanularidae.

The Campanularidae include 7 genera and 138 species, of which all but 23 are species of the three principal genera, Campanularia, Clytia, and Obelia.

Campanularia, a genus of 62 species, is the largest of the three. Found in every region of the world except the barren (of hydroids) Mexican province, the genus is most abundant along the east and west shores of the North Atlantic, in the Mediterranean, and along the shores of Southern Alaska to Puget Sound. These regions are practically equal in number of species, and over half the species are common to both Atlantic and Pacific.

In the provinces bounding the North Atlantic, the species are largely identical. The South Atlantic species and 2 of the Mascarene species are also found in the North Atlantic. In the Pacific, the Arctic Asiatic, Arctic Alaskan, and Japanese species belong to the South Alaskan fauna. There are a number of scattered species in the South Pacific and Mascarene, and some well distributed through these regions; this is not surprising, in view of the long distance from the source, and the greater differentiation which tropical waters would work on a shallow-water group such as this.

Campanularia is found almost entirely in water under 100 fathoms in depth, and attains its maximum development in Zone I.

Clytia, a genus of 26 species, is equally abundant in each of the following provinces:- West Indian, Eastern

Table #10.

CAMPANULARIDAE.

Species	Atlantic: Brit. Pat.	Atlantic: W.I.	Atlantic: E.N.A.	Atlantic: Arc.Atl.	Atlantic: Arc.Eur.	Atlantic: Cont.	Atlantic: Med.	Atlantic: W.Af.	Atlantic: S.Af.	Indian: E.Af.	Indian: Mase.	Indian: Kerg.	Pacific: N.Z.	Pacific: S.Aus.	Pacific: N.Aus.	Pacific: Ocean.	Pacific: Jap.	Pacific: Haw.	Pacific: Arc.As.	Pacific: Arc.Al.	Pacific: S.Al.	Pacific: Cal.	Pacific: Mex.	Pacific: Mag.	Pacific: Peru.	Antarctic	Bathymetrical in fm.
Campanularia:-																											
C.acuta(Marktanner-T.)	—																										—
C.alta(Stechow)							+																				0-10
C.amphora(Agassiz)			+																								"Sh.W."
C.angulata(Hincks)	+		+			+	+														+						0-10
C.armata(Pictet&Bedot)						+																					72-222
C.brachycaulis(Stechow)							+																				0-10
C.brevicaulis(Nutting)		+																									194
C.brevithecata(Thorneley)																+											0-10
C.calceolifera(Hincks)			+				+	+																			0-10
C.circula(Clarke)																					+						12-18
C.cheloniae(Allman)										+	+																-25-
C.chinensis(Marktanner-T.)																	+										—
C.coruscans(Schneider)							+																				0-20
C.costata(Bale)															+												5-27
C.cylindrica(Allman)											+					+											—
C.decipiens(Wright)							+																				0-20
C.eloisa(Nutting)																		+									59-139
C.exigua(Sars)							+	+													+						0-10
C.flexuosa(Hincks)			+	+	+	+	+	+													+						0-1
C.fragilis(Hincks)			+			+																					0-1
C.fusiformis(Clarke)																					+	+					0-1
C.gigantea(Hincks)			+				+	+																			5-60
C.gravieri(Billard)								+																			54
C.groenlandica(Levinsen)			+	+			+										+		+		+						11-284
C.hesperia(Torrey)																						+					0-20
C.hincksi(Alder)			+	+	+	+	+	+		+	+						+				+	+					20-100
C.insignis(Allman)			+																								0-30
C.integra(MacGillivray)	+		+	+	+	+	+	+					+	+	+		+				+			+			3-255
C.intermedia(Stechow)								+																			1-10
C.juncea(Allman)										+	+																-20-
C.junceoides(Borradaile)											+																20-25
C.kincaidi(Nutting)																					+						—
C.laevis(Hartlaub)																								+	+		1-20
C.lairii(Lamouroux)															+	+											—
C.lennoxensis(Jäderholm)	+	+																									12-28
C.macrocyttara(Lamouroux)															+	+											0-10
C.macroscypha(Allman)			+																								27-373
C.magnifica(Fraser)				+																							50-72
C.marginata(Allman)			+																								0-440
C.marginata(Bale)															+												0-10
C.obtusidens(Jäderholm)																								+			10-15
C.occidentalis(Fewkes)																						+					—
C.pacifica(A.Agassiz)																					+	+					0-1
C.ptychocyathus(Allman)			+					+																			2-10
C.rara(Stechow)								+																			0-10
C.raridentata(Alder)				+			+	+	+				+				+			+							0-250
C.reptans(Lamouroux)																										+	0-20
C.retroflexa(Allman)																		+									20-40
C.rigida(A.Agassiz)																						+					—
C.ritteri(Nutting)																					+	+					20-31
C.rufa(Bale)																	+										20
C.serrulatella(Borradaile)													+														25-42
C.speciosa(Clarke)				+	+	+	+										+		+		+						6-40
C.spinulosa(Bale)													+	+	+			+									52-120

CAMPANULARIDAE.

Species	Atlantic										Indian		Pacific											Antarctic	Bathymetrical in fm.
	Brax. Pat.	W.I.	E.N.A.	Arc.Atl.	Arc.Eur.	Cont.	Med.	W.Af.	S.Af.	E.Af.	Ter.	Masc.	N.Z.	S.Aus.	N.Aus.	Ocean.	Jap.	Hon.	Arc.As.	Arc.Al.	S.Al.	Cal.	Mex.	Peru.	Mag.		
Campanularia(cont.):-																											
C.spiralis(Nutting)																	+										58
C.tincta(Hincks)	+													+	+										+		4-8
C.tulipifera(Allman)	+																+									+	-150
C.undulata(Lamouroux)														+													0-20
C.urnigera(Lamouroux)														+	+												0-10
C.verticillata(Linn.)			+	+	+	+	+										+		+	+	+	+					16-300
C.villafrancensis(Stechow)							+																				0-20
C.volubilis(Linnaeus)			+	+	+	+	+										+		+		+	+					0-170
Clytia:-																											
C.attenuata(Calkins)																					+						0-10
C.arborescens(Pictet)								+																			54
C.bakeri(Torrey)																						+					0-10
C.coronata(Clarke)			+	+																				+			0-10
C.cylindrica(Agassiz)				+																	+						1-25
C.delicatula(Thorneley)																	+	+									23-40
C.edwardsi(Nutting)				+										*				+			+	+					0-10
C.elongata(Marktanner-T.)														+													—
C.elsae-oswaldae(Stechow)			+																								0-10
C.flavidula(Metschnikoff)	—																										—
C.fragilis(Congdon)			+																								1-14
C.geniculata(Thorneley)								+				+															1-10
C.hendersoni(Torrey)																						+					3
C.johnstoni(Alder)			+	+	+	+	+	+				+	+								+	+					0-100
C.linearis(Thorneley)																	+	+									-44-
C.longicyatha(Allman)			+	+			+	+									+										0-90
C.minuta(Nutting)				+																							0-10
C.mollis(Stechow)								+																			0-10
C.noliformis(McCrady)			+	+								+						+			?+						0-20
C.obeliformis(Stechow)						+																					—
C.paulensis(Vanhoffen)								+				+															0-1
C.sargassicola(Nutting)			+																								"fl."
C.serrulata(Bale)								+				+	+	+	+												0-10
C.ulvae(Stechow)								+																			0-10
C.universitatis(Torrey)											+										+	+					10-12
C.warreni(Stechow)									+																		—
Gonothyraea:-																											
G.bicuspidata(Clarke)		+		+				+									+	+									0-20
G.clarki(Marktanner-Turn.)				+		+														+	+	+					0-20
G.gracilis(Sars)				+	+	+	+	+																+	+		0-110
G.hyalina(Hincks)					+	+	+	+																			44-158
G.inornata(Nutting)																						+					—
G.loveni(Allman)				+	+	+	+	+																			0-55
G.nodosa(Stechow)		+																									0-10

"Marktanner-T." --- Marktanner-Turneretscher.

CAMPANULARIDAE.

Species.	Atlantic.								Indian.			Pacific.										Antarctic	Bathymetrical in fm.
	Brāz. Pat.	W.I.	E.N.A.	Arc. Atl.	Arc. Eur. Cont.	Med.	W. Af.	S. Af.	E. Af.	Trop.	Mase.	N.Z.	S. Aus.	N. Aus.	Ocean	Jap.	Haw.	Arc. As.	Arc. Al.	S. Al.	Cal.	Mex.	Peru.	Mag.		
Obelia:-																										
O.andersoni(Hincks)											+															1-10
O.angulosa(Bale)	+												+													–
O.articulata(A.Agassiz)			+																							–
O.australis(vonLendenfeld)											+	+	+	+												1-10
O.austro-georgiae(Jäderh.)	+																									1-10
O.bifurcata(Hincks)						+		+		+	+															10-222
O.bcrealis(Nutting)																				++						1-10
O.braziliensis(Meyen)	+																									"fl."
O.castellata(Clarke)																						+				782
O.commissuralis(McCrady)			+																		+					0-10
O.corona(Torrey)																				++						1-10
O.dichotoma(Linnaeus)		+	+	+	+	+	+	+				+?							+	++						0-64
O.dubia(Nutting)																				+						–
O.flabellata(Hincks)	+		+	+	+	+										+				+?						0-25
O.fragilis(Calkins)																				+						0-82
O.gelatinosa(Pallas)	+		+	+	+	+	+													+	+	+				1-30
O.geniculata(Linnaeus)	+	+	+	+	+	+	+			+	+		+	+		+	+			+	+		+	+	+	0-42
O.gracilis(Calkins)																				+						1-10
O.griffini(Calkins)																				+						–
O.hyalina(Clarke)			+	+		+		+			+															1-68
O.longissima(Pallas)	+			+	+	+	+			+									+	+	+			+	+	0-94
O.multicilia(Browne)																								+		–
O.multidentata(Fraser)																				+						0-20
O.nigrocaulus(Hilgendorf)												+														0-1
O.oxydentata(Stechow)			+																							0-10
O.plicata(Hincks)						+														+						1-10
O.serrulata(Bale)													+	+												40
Orthopyxis:-																										
O.asymmetrica(Stechow)						++														+++						0-10
O.caliculata(Hincks)	+			+	+	+	+	+				+	+	+										+	+	1-100
O.clytioides(Lamouroux)			+			+																		+		6-20
O.compressa(Clarke)							+													++		+				"fl."
O.crenata(Hartlaub)			+					+				+												+		1-7
C.everta(Clarke)																					+				+	1-42
O.volubiliformis(Sars)							+																			0-10
Siliculariá:-																										
S.asymmetrica(Hilgendorf)												+														0-10
S.atlantica(Marktanner-T.)																							+			–
S.bilabiata(Coughtrey)												+	+	+												0-10
S.hemispherica(Allman)	+																							+	+	–
S.pedunculata(Jäderholm)	+																									0-1
S.repens(Allman)											+													+		0-10
S.reticulata(Hartlaub)	+																									0-10
S.rosea(Meyen)	+								+		+													+		0-10
Thaumantias:-																										
T.inconspicua(Forbes)	+					++		+				+					+			+				++		–

North American, Mediterranean, Mascarene, Japanese, South Alaskan, and Californian. Eight of the 16 species found in the Pacific are found likewise in the Atlantic or Mediterranean, while all 5 Mascarene species are also present in the Atlantic. Clytia is more uniformly distributed than Campanularia, and this may be explained by recalling that Clytia belongs almost exclusively to the first zone of depth.

Obelia, a genus of 27 species, is likewise largely confined to Zone I, and is even more uniformly distributed than Clytia. In the North Atlantic Ocean, the Eastern North American, Arctic Atlantic and European, and Continental provinces yield 5 species common to all. All the species found in the South Atlantic belong to the North Atlantic group.

The Pacific species form a fairly distinct group, only 8 of the 19 being found in both Pacific and Atlantic. Two of the Mascarene species belong to the European fauna, one to that of the South Pacific, and one is local.

We have evidence in this genus of migration at a more remote date than that of Campanularia and Clytia, both in the greater range to which it has attained and in the large measure of separation between the faunas of the Atlantic and Pacific Oceans. When we recall that many species of Obelia go through a free medusa-stage, while Clytia and nearly all species of Campanularia do not, this earlier migration will have been accounted for at once.

The other four genera, Orthopyxis, Gonothyraea, Thaumantias, and Silicularia, follow the three major genera in being most abundant either in the North Atlantic or North Pacific or both, with the exception of the last-named, which is found only in southern latitudes throughout the world, making it one of the few hydroids whose distribution indicates an antarctic origin. All four genera live almost entirely within Zone I.

The Campanularidae, then, are a shallow-water family, mostly arctic, and of universal and fairly uniform distribution. Obelia was probably the first major genus to migrate southward, and the migration of the family as a whole probably commenced rather late, as compared with that of other families. In general, a long period of migration results in differentiation into a large number of genera in relation to species; the reverse is true in the Campanulariidae, whose 7 genera to 138 species plainly indicates a shorter migration period.

12. Synthecidae.

The Synthecidae are the connecting link between the Campanularidae and the next family, the Sertularidae; the polyps are provided with the open hydrotheca characteristic of the former, but are sessile and bilaterally arranged like the latter. In the family there are 3 genera and 16 species. I have been unable to obtain the statistics of 1 genus, Lytoscyphus subrufus (Jäderholm), and so must leave this form out of the discussion.

Table #11.

SYNTHECIDAE.

Species.	Atlantic.									Indian.			Pacific.											Antarctic	Bathymetrical in fm.
	Pat.	Braz.	W.I.	E.N.A.	Arc.Atl.	Arc.Eur.	Cont.	Med.	N.Atl.	S.Atl.	E.Afr.	Berg.	Masc.	N.Z.	S.Aus.	N.Aus.	Ocean	Jap.	Haw.	Arc.As.	Arc.Al.	C.Al.	Cal.	Mex.	Peru.	Magr.		
Hypopyxis:-																											
H.labrosa(Allman)															+												150
Lytoscyphus:-																											
L.subrufus(Jaderholm)	—																										—
Synthecium:-																											
S.alternans(Allman)															+												30-35
S.campylocarpum(All.)															+	+	+	+	+								8-35
S.chilense(Hartlaub)																									+		—
S.cylindricum(Bale)														+	+	+								+			5-29
S.elegans(Allman)															+												1-10
S.evansi(Ellis&Solander)								+																			1-2
S.maldivense(Borradaile)												+		+													1-36
S.orthogonium(Busk)														+		+			+								14-16
S.patulum(Busk)															+												—
S.ramosum(Allman)															+	+											—
S.rectum(Nutting)			+																								276
S.robustum(Nutting)																									+	+	-21-
S.tubiger(Borradaile)														+													20-40
S.tubithecum(Allman)			+													+	+	+	+								18-114

The Synthecidae afford us the second example of hydroids which have migrated north from an antarctic source, the first case being Silicularia, of the Campanularidae. The genus Synthecium, which contains all but one of the species, is most abundant (4 species) in the New Zealand and Mascarene, and in the South Australian (6 species), while scattered representatives of the genus are found in the Indian Ocean, and in the Pacific as far north as Japan, Hawaii, and California. The only representatives in the Atlantic Ocean are 2 species in the West Indian province and 1 in the Mediterranean. Hypopyxis labrosa (Allman), the only form outside the genus Synthecium, comes from South Australia.

In depth, Synthecium lives almost exclusively in Zones I and II, while the single specimen of Hypopyxis was found in Zone IV.

In a family so small as this there are scarcely sufficient data for many conclusions. We may be sure, however, that this migration was from Antarctic regions, and that it must have been at an early time to have effected even the existing distribution.

13. Sertularidae.

The Sertularidae form the second largest family of hydroids, containing 18 genera and 289 species. The largest family are the Plumularidae, with 306 species. All but 28 species of Sertularidae are included within the 6 major genera:- Sertularella (96); Sertularia (60); Thuiaria (40); Diphasia (25); Abietinaria (20); Selaginopsis (20). These genera are all of sufficient to merit individual discussion.

The first genus, Sertularella, is found in every province, but is most abundant in five widely separated regions:- the West Indies, Australia, Japan, Alaska, and Cape-Horn and Patagonia. A comparison of the species found in these regions shows that in no one of the five regions are there more than one-third of the species of Sertularella which are found in any other one province; in most cases the proportion is much smaller. These areas are in a large measure distinct from one another.

Comparing groups of provinces in the different oceans, we find all the provinces of the North Atlantic connected by a large number of forms common to all or most of them. The same is true of the provinces in the South Atlantic and in the South Pacific. To the group centering in the North Atlantic belong the species found in the Mediterranean, West and South African; to the Magellanic-Patagonian group belong species from South Africa, Kerguelen, and Australia, (nearly one-half of the species). This indicates an antarctic source for at least those groups of Sertularella centering about Cape Horn and Australia, and that the former province was populated mainly from the Australian.

The statement has been made that independent, bipolar development within a single genus was inconcievable. So, regarding the question of a southern origin for the entire genus, we find:- a) of the 13 species found in one or more of the 4 Arctic provinces, 4 are local and 9 are found in

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Table #12.

SERTULARIDAE.

Species	Atlantic: Brax. Pat.	W.I.	E.N.A.	Arc. Atl.	Arc. Eur.	Cont.	Med.	W. Af.	S. Af.	Indian: E. Af.	Kerg.	Mass.	Pacific: N.Z.	S. Aus.	N. Aus.	Ocean.	Jap.	Haw.	Arc. As.	Arc. Al.	S. Al.	Cal.	Mex.	Mag. Peru.	Antarctic	Bathymetrical (fms.)
Abietinaria:-																										
A.abietina(Linnaeus)			+	+	+	+	+	+	+								+		+	+	+					20-284
A.alexanderi(Nutting)																					+					55-56
A.amphora(Nutting)																					+					56-171
A.anguina(Trask)																				+	+	+				80-72
A.annulata(Kirchenpauer)																					+					36
A.coei(Nutting)																				+	+					-
A.compressa(Mereschkowsky)																	+									-
A.costata(Nutting)																					+					-
A.filicula(Ellis&Solander)			+	+	+	+											+			+	+					0-40
A.gigantea(Clark)																				+	+					26-48
A.gracilis(Nutting)																					+					40-283
A.greenei(Murray)																					+	+				-
A.inconstans(Clarke)																					+					Sh. w.
A.juniperus(Kirchenpauer)																	+									-
A.melo(Kirchenpauer)																	+									-
A.rigida(Fraser)																					+					48
A.tilesii(Kirchenpauer)																	+									-
A.traski(Torrey)																	+				+	+				40-204
A.turgida(Clarke)																				+	+					-
A.variabilis(Clarke)																	+		+	+	+	+				0-633
Calamphora:-																										
C.campanulata(Warren)									+																	0-10
Desmoscyphus:-																										
D.palkensis(Thorneley)												+														7
D.obliquus(Allman)															+											8-20
Dictyocladium:-																										
D.dichotomum(Allman)														+												38-40
D.flabellum(Nutting)																					+					27-72
D.fuscum(Hickson&Gravely)																									+	8-15
D.reticulatum(Kirchenpauer)														+												-
Diphasia:-																										
D.alata(Hincks)					+	+																				40-222
D.attenuata(Hincks)						+		+	+			+		+												0-25
D.bipinnata(Allman)									+																	-
D.clarae(Fraser)																					+					-
D.corniculata(Murray)																						+				-
D.coronifera(Allman)						+																				632
D.derbeki(Kudelin)																	+									-
D.digitalis(Busk)		+	+									+	+		+											4-213
D.elegans(					+																					150-200
D.fallax(Johnston)			+	+	+	+																				1-532
D.kincaidi(Nutting)																				+	+					-
D.mutulata(Busk)										+		+				+										5-60
D.nuttingi(Stechow)																	+									38-98
D.paarmani(Nutting)			+																							270-446
D.palmata(Nutting)																	+	+								-184-
D.pinaster(Ellis&Solander)					+	+		+	+																	40-314
D.pinnata(Pallas)						+			+				+	+												30-75
D.pulchra(Nutting)				+	+														+		+					67-122
D.rosacea(Linnaeus)			+	+	+	+			+						+	+										0-50
D.scalariformis(Kirkpatrick)																	+									-
D.sub-carinatus(Busk)															+											45
D.tamarisca(Linnaeus)			+	+	+	+	+																			30-660
D.thorpeleyi(Ritchie)												+														-
D.tropica(Nutting)		+																								Sh. w.
D.wandeli(Levinsen)				+	+	+																				67-135

TABLE XIX.

Table #12(continued)

SERTULARIDAE.

Species	Atlantic: Pat.	Brak.	W.I.	E.N.A.	Arc.Atl.	Arc.Eur.	Cont.	Med.	W.Af.	S.Af.	Indian: E.Af.	Terg.	Masc.	Pacific: N.Z.	S.Aus.	N.Aus.	Ocean.	Jap.	Haw.	Arc.As.	Arc.Al.	S.Al.	Cal.	Mex.	Mag.	Peru.	Antarctic	Bathymetrical in f.m.
Hydrallmania:-																												
H.bicalycula(Coughtrey)															+	+												
H.distans(Nutting)																						+	+					—
H.falcata(Linnaeus)				+	+	+	+			+										+								1-1100
H.franciscana(Trask)																							+					"beach"
Idiella:-																												
I.pristis(Lamouroux)		+									+		+	+	+	+	+	+										0-1343
Lineolaria:-																												
L.flexuosa(Bale)															+													—
L.spinulosa(Hincks)															+													1-10
Odontotheca:-																												
O.bidens(Bale)										+																		—
O.operculata(Linnaeus)	+	+		+	+		+			+		+	+	+	+		+				+		+			+	+		1-450
Pasythea:-																												
P.hexodon(Busk)													+			+	+											5-27
P.quadridentata(El.&Sol.)			+	+					+						+	+	+	+	+									1-14
Selaginopsis:-																												
S.allmani(Norman)																		+										—
S.arctica(Bonnevie)						+																						209
S.bidentata(Allman)																		+										—
S.cedrina(Linnaeus)																		+			+							—
S.cylindrica(Clarke)																					+	+						0-17
S.decemserialis(Mereschkowsky)					+													+			+							—
S.fusca(Johnston)				+	+	+														+	+							—
S.hartlaubi(Hutting)																				+		+						-48-
S.mirabilis(Verrill)			+	+	+	+												+		+	+	+						25-60
S.novae-zelandiae(Thompson)														+														—
S.obsoleta(Lepechin)					+															+	+							23-25
S.ochotensis(Mereschkowsky)																		+										—
S.ornata(Nutting)																						+						45
S.pinaster(Lepechin)																				+	+							—
S.pinnata(Mereschkowsky)																		+			+	+						23-25
S.plumiformis(Nutting)																					+							—
S.tatarica(Kudelin)																		+										—
S.thuja(Mereschkowsky)																		+										—
S.triserialis(Mereschkowsky)																		+					+					-31-
S.urceolifera(Kirchenpauer)												+																—
Sertularella:-																												
S.africana(Warren)										+																		—
S.albida(Kirchenpauer)																		+			+	+						6-20
S.allmani(Hartlaub)	+											+													+			7-20
S.amphorifera(Allman)		+									+																	101-478
S.arborea(Kirchenpauer)										+																		25
S.arboriformis(Marktanner-T.)													+															—
S.areyi(Nutting)			+															+										98-200
S.capillaris(Allman)															+													—
S.catena(Allman)			+																									390
S.clarkei(Mereschkowsky)																			++									-1847
S.clausa(Allman)		+																										600
S.complexa(Nutting)																			+									45-280
S.conica(Allman)	+		++			+														+				+				5-60
S.contorta(Kirchenpauer)	+											+					+								++			0-1
S.crassicaulis(Heller)							+																					18-27

Species

SERTULARIDAE.

Species	Atlantic: Brazil. Pat.	W.I.	E.N.A.	Arc.Atl.	Arc.Eur.	Cont.	Med.	W.Af.	S.Af.	Indian: Mass.	Aden.	E.Af.	Pacific: N.Z.	S.Aus.	N.Aus.	Ocean.	Cap.	Han.	Arc.As.	Arc.Al.	S.Al.	Col.	Mex.	Mag. I.&S.	Antarctic	Bathymetrical in fm.
Sertularella(cont.):-																										
S.crenulata(Nutting)	+																	+								44-134
S.cumberlandica(Jäderholm)																		+						+ +	+	38-98
S.dentifera(Torrey)																		+			+					14-293
S.diffusa(Allman)									+																	—
S.distans(Allman)		+																								26-163
S.divaricata(Busk)	+													+									+			—
S.echinocarpa(Allman)										+																28-60
S.elegans(Nutting)																					+					72
S.ellisii(Hincks)							+																			0-20
S.episcopus(Allman)													+											+ +		0-30
S.exigua(Thompson)													+													0-10
S.exserta(Allman)																+										76
S.filiformis(Allman)	+																							+ +		-9-
S.flexilis(Hartlaub)																								+		—
S.formosa(Fewkes)		+ +					+ +		+																	2-357
S.fusiformis(Hincks)			+				+ + +						+									+		+		0-10
S.gayi(Lamouroux)		+ + + +					+ + + + +						+				+							+	+	25-605
S.gigantea(Mereschkowsky)			+ +														+		+ +						+	5-142
S.gotoi(Stechow)																	+									—
S.hartlaubi(Nutting)		+																						+		33-52
S.inabai(Stechow)																	+									2-12
S.infracta(Kirchenpauer)														+												—
S.interrupta(Pfeffer)	+																									—
S.johnstoni(Gray)													+ + + +													—
S.laevis(Bale)														+ +												0-10
S.lagenoides(Stechow)							+																			0-20
S.leiocarpa(Allman)									+																	100-500
S.levinseni(Nutting)																					+					72
S.longitheca(Bale)														+												—
S.macrotheca(Bale)														+												0-10
S.magellanica(Marktanner-T.)																								+		50
S.magna(Nutting)																				+						283
S.margaritacea(Allman)																								+		—
S.mediterranea(Hartlaub)									+	+																28-82
S.megastoma(Nutting)		+																								167
S.meridionalis(Nutting)																								+		122
S.milneana(d'Orbigny)	+																									20-21
S.minuta(Nutting)																					+					283
S.modesta(Hartlaub)																								+		0-1
S.monopleura(Marktanner-T.)														+												—
S.muelleri(Kirchenpauer)															+											—
S.neglecta(Thompson)														+												0-20
S.paessleri(Hartlaub)	+																									0-10
S.pallida(Kirchenpauer)				+																						—
S.parvula(Allman)														+												38
S.patagonica(d'Orbigny)	+																									"bch."
S.pedrensis(Torrey)																						+				0-20
S.picta(Meyen)	+								+															+		-7-
S.pinnata(Clarke)				+													+				+					0-112
S.pinnigera(Hartlaub)		+																								3-4
S.plectilis(Hickson&Gravely)																									+	20-130
S.pluma(Kirchenpauer)														+												—

SERTULARIDAE.

Species.	Atlantic. Brez. Pat.	Atlantic. W.I.	Atlantic. E.N.A.	Atlantic. Arc.Atl.	Atlantic. Arc.Eur.	Atlantic. Cont.	Atlantic. Med.	Indian. W.Af.	Indian. S.Af.	Indian. E.Af.	Indian. Aera.	Indian. Masc.	Pacific. N.Z.	Pacific. S.Aus.	Pacific. N.Aus.	Pacific. Ocean.	Pacific. Jap.	Pacific. Haw.	Pacific. Are.As.	Pacific. Are.Al.	Pacific. S.Al.	Pacific. Col.	Pacific. Mex.	Pacific. Peru.	Pacific. Magc.	Antarctic	Bathymetrical in fm.
Sertularella(cont.):-																											
S.polyzonias(Linnaeus)	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+			+	+	+			+	+		0-374
S.protecta(Hartlaub)	+																							+	+		0-1
S.quadrata(Nutting)		+																									67-194
S.quadridens(Bale)													+	+													4-14
S.quadrifida(Hartlaub)	+													+	+	+									+		5-70
S.rectitheca(Ritchie)	+			*																							65
S.robusta(Coughtrey)														+													—
S.rubella(Kirchenpauer)																		+									—
S.rugosa(Linnaeus)		+	+	+	+	+														+	+						1-54
S.secunda(Kirchenpauer)									+																		—
S.sieboldi(Kirchenpauer)		+																									—
S.sinensis(Jäderholm)																		+									32-135
S.solidula(Bale)														+	+			+									-3-
S.speciosa(Congdon)		+																									Sh.w.
S.spinosa(Kirchenpauer)																		+									—
S.spiralis(Hickson&Gravely)																										+	130
S.subdichotoma(Kirchenpauer)	+													+										+	+		-2-60
S.tanneri(Nutting)																					+						40
S.tenella(Alder)		+		+	+	+			+			+	+	+							+				+	0-103
S.tongensis(Stechow)																	+										—
S.torreyi(Nutting)																			+								70-406
S.tricuspidata(Alder)			+	+	+	+											+			+	+					+	0-1320
S.tridentata(Lamouroux)														+	+	+		+								+	0-20
S.trimucronata(Allman)															+												—
S.trispinosa(Coughtrey)														+	+										+		-6-
S.trochocarpa(Allman)															+												—
S.tropica(Hartlaub)																							+				450-1168
S.turbinata(Lamouroux)													+	+	+			+									3-18
S.turgida(Trask)																		+			+	+					0-204
Sertularia:-																											
S.acanthostoma(Bale)															+												0-1
S.aestuaria(Congdon)			+																								0-2
S.amplectens(Allman)				+																							"fl."
S.aperta(Allman)										+																	—
S.arbuscula(Lamouroux)															+	+											—
S.australis(Kirchenpauer)																					+						0-10
S.bicornis(Bale)															+												0-18
S.bispinosa(Gray)														+	+	+											-50-
S.brevicyathus(Versluys)			+						+								+										1-15
S.buskii(Allman)															+												—
S.challengeri(Nutting)		+													+												38-40
S.conferta(Kirchenpauer)																+											0-10
S.cornicina(McCrady)			+	+	+										+	+					+						0-8
S.crenata(Bale)															+												0-10
S.crinis(Allman)															+												—
S.crincidea(Allman)										+																	0-20
S.decipiens(														+		+											-8-
S.densa(Stechow)	—																										—
S.desmoides(Torrey)																						+					1-42
S.distans(Lamouroux)			+			+	+	+						+		+		+									0-67
S.divergens(Lamouroux)															+												0-10

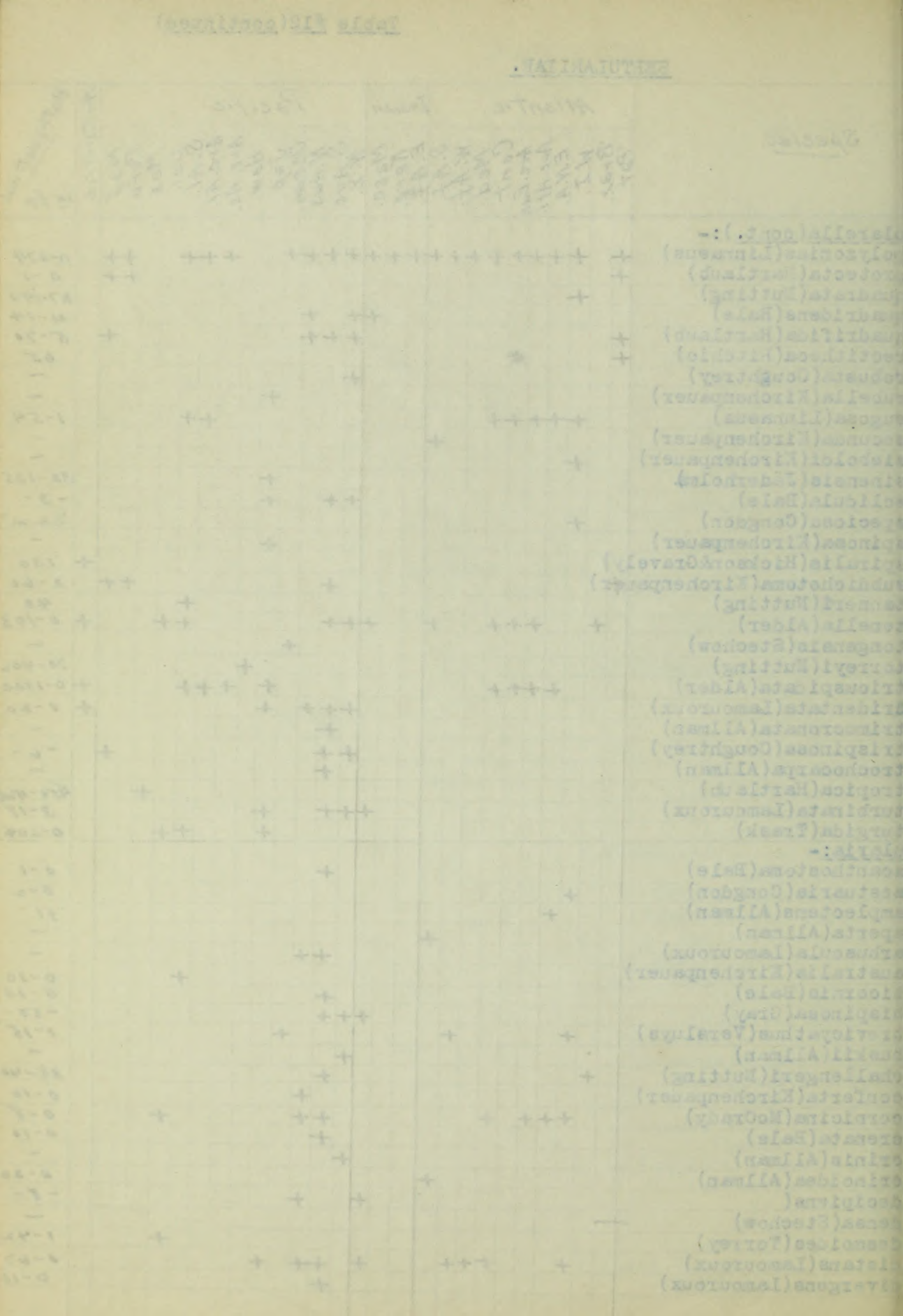


Table #12(continued)

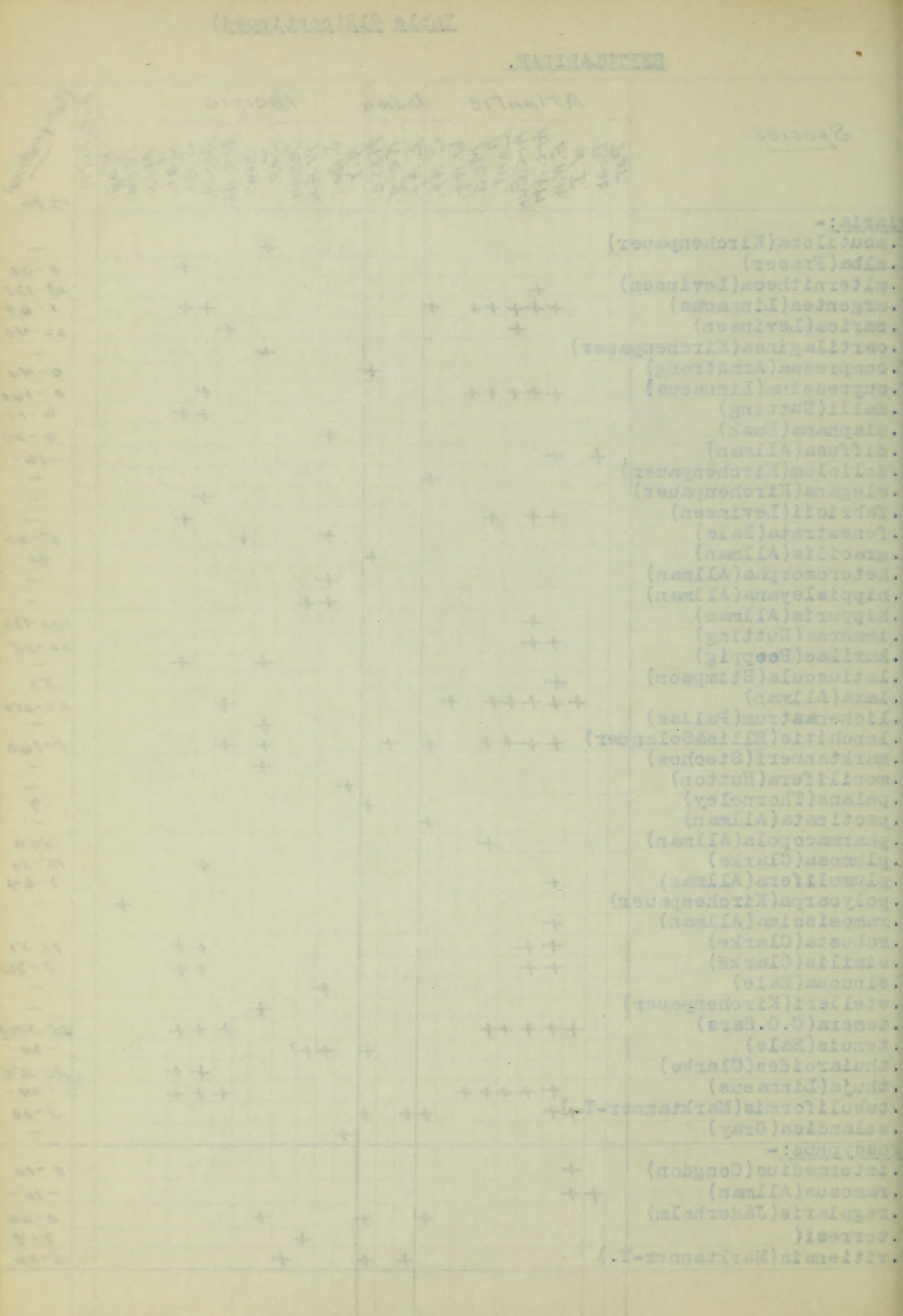
SERTULARIDAE.

Species.	Atlantic: Brzl. Pat.	W.I.	E.N.A.	Arc.Atl.	Arc.Eur. Cont.	Med.	W.Af.	S.Af.	Indian: E.Af.	Terr.	Mase.	N.Z.	Pacific: S.Aus.	N.Aus.	Ocean.	Isl.	Haw.	Arc.As.	Arc.Al.	S.Al.	Cal.	Mex.	Pe-n.	Magf.	Antarctic	Bathymetrical In fms.
Sertularia(cont.):-																										
S.elongata(Lamouroux)					+								+	+												0-10
S.fissa(Thorneley)												+														6-30
S.flexilis(Thompson)														+												0-10
S.flowersi(Nutting)			+																							150
S.geminata(Bale)														+												0-10
S.grosse-dentata(Kirchenpauer)														+												0-20
S.heterodonta(Ritchie)		+																								36
S.humilis(~~Armstrong~~ Cunfton)			+																							0-1
S.huttoni(Marktanner-T.)													+													-
S.indomalayica(Campenhausen)												+			+											-
S.insignis(Thompson)														+												0-10
S.laevimarginata(Ritchie)							+								+											-
S.ligulata(Thorneley)												+														1-10
S.littoralis(Thorneley)															+											0-1
S.macrocarpa(Bale)														+												0-10
S.maplestonei(Bale)														+												0-10
S.marginata(Allman)			+		+																					303-324
S.mayeri(Nutting)			+				+								+											0-36
S.megalocarpa(Allman)														+	+											-
S.minima(Thompson)								+	+					+	+	+										0-10
S.minuta(Bale)														+												0-10
S.nasonowi(Kudelin)																+										-
S.orifissa(Allman)														+												-
S.penna(Kirchenpauer)														+												0-10
S.perpusilla(Stechow)							+																			0-16
S.pulchella(d'Orbigny)	+													+								+	+			0-24
S.pumila(Linnaeus)			+	+	+	+	+	+					+									+				0-12
S.pusilla(Thorneley)															+											0-20
S.ramulosa(Coughtrey)													+													-
S.rathbuni(Nutting)		+	+																							20-36
S.recta(Bale)														+												-
S.rugosissima(Thorneley)												+														1-10
S.snyderi(Nutting)															+	+										163
S.stolonifera(Hartlaub)																									+	308
S.stookeyi(Nutting)			+	+																						1-10
S.trigonostoma(Busk)														+	+											-
S.tuba(Bale)														+												0-10
S.tubiformis(Lamouroux)														+	+											-
S.tumida(Allman)				+																						Sh. w.
S.unguiculata(Busk)													+	+												0-10
S.versluysi(Nutting)			+	+			+		+						+											1-30
Staurotheca:-																										
S.antarctica(Hartlaub)																									+	271
S.dichotoma(Allman)																+										85-100
S.reticulata(Ritchie)	+																									65
Stereotheca:-																										
S.pluridentata(Kirchenpauer)									+																	-
Thuiella:-																										
T.subarticulata(Coughtrey)													+													-

Table #12(continued)

SERTULARIDAE.

Species	Atlantic: Brax. Sat.	Atlantic: E.N.Atl. W.I.	Atlantic: Arc.Eur.	Atlantic: Cont. Med.	Atlantic: W.Atl.	Atlantic: S.Atl.	Indian: E.Atl.	Indian: Reg.	Indian: Mosc.	Pacific: N.Z.	Pacific: S.Aus.	Pacific: N.Aus.	Pacific: Ocean	Pacific: Jap.	Pacific: Haw.	Pacific: Arc.As.	Pacific: Arc.Al.	Pacific: S.Al.	Pacific: Cal.	Pacific: Mex.	Pacific: Magf. Peru.	Antarctic	Bathymetrical in fm.
Thuiaria:-																							
T.acutiloba(Kirchenpauer)														+									—
T.alba(Fraser)																			+				0-20
T.alternitheca(Levinsen)		+																					28-173
T.argentea(Linnaeus)		+++++				+											++						1-60
T.carica(Levinsen)		+														+							22-40
T.cartilaginea(Kirchenpauer)														+									—
T.compressa(Armstrong)									+														0-40
T.cupressina(Linnaeus)		+++++															+						0-160
T.dalli(Nutting)																	++						6-13
T.diaphana(Busk)											+												0-20
T.diffusa(Allman)	+	+																					-16-
T.doliolum(Kirchenpauer)						+																	—
T.elegans(Kirchenpauer)																	+						—
T.fabricii(Levinsen)		++	+															+					—
T.fenestrata(Bale)											+		+										6-20
T.gracilis(Allman)									+														30
T.heteromorpha(Allman)											+												—
T.hippisleyana(Allman)											++												—
T.hippuris(Allman)		+																					182-172
T.immersa(Nutting)		++																					22-26
T.kurilae(Poeppig)														+					+				—
T.latiuscula(Stimpson)		+																					33
T.laxa(Allman)		+++++				+											+						22-250
T.lichenastrum(Pallas)														+									—
T.lonchitis(Ellis&Solander)		++++				+		+						+			+						8-160
T.marktanneri(Stechow)														+									—
T.monilifera(Hutton)										+													—
T.palans(Thorneley)									+														?
T.pectinata(Allman)							+																-
T.pharmacopola(Allman)				+																			45-0
T.plumosa(Clarke)																			+				15-30
T.plumulifera(Allman)		+																					?-64
T.polycarpa(Kirchenpauer)																					+		—
T.ramosissima(Allman)		+																					—
T.robusta(Clarke)		++																	++				13-51
T.similis(Clarke)		++																	++				8-72
T.sinuosa(Bale)															+								—
T.stelleri(Kirchenpauer)															+								—
T.tenera(G.O.Sars)		+++++																	+	++			25-200
T.tenuis(Bale)									+				++?										-20-
T.thuiaroides(Clarke)																			++				20-185
T.thuja(Linnaeus)		+																	+	++			-24-
T.tubuliformis(Marktanner-T.)		++					++		+														3-10
T.zelandica(Gray)										+													—
Thyroscyphus:-																							
T.intermedius(Congdon)		+																					0-10
T.ramosus(Allman)	++																						-10-
T.regularis(Jäderholm)							+		+					+									0-20
T.torresi(													+										?-9
T.vitiensis(Marktanner-T.)								+	+					+									8-26



more southern provinces; b) only 23 of the 96 species of Sertularella are not found within or south of the tropics; of these, 17 are local, and of the 17, 7 are from Japan or Hawaii, the faunas of both these regions being most closely allied to that of Australia and Oceania. This leaves only 15 species which at the present time are strictly northern, or less than one-sixth of the genus, presenting a strong argument in favor of antarctic origin.

The Australian area seems to be the center from which the migration has gone on. The west-flowing currents have carried the hydroids into the Atlantic, via the Mascarene and South African provinces, and thence to the North Atlantic.

In depth, Sertularella is equally abundant in Zones I and II, and somewhat less so in Zones III and IV. Nearly one-sixth of the species are found in Zone V, an unusually large proportion.

It is perhaps well to note that this time that the Sertularidae contain a very large number of local species. in Sertularella, for instance, 61 of the 96 species are local, while 19 more are confined to two or three provinces. The significance of this will be discussed later.

Sertularia, the genus next in importance, centers about Australia, and 43 of the 60 species occur in the New Zealand-Australian-Oceanic group of provinces. If the Mascarene and Japanese provinces are included, the number rises to 47.

There is a sort of subsidiary center in the West Indian

province, containing 12 species, but 6 of these belong also in some one of the South Pacific group of provinces, and the West Indian forms have undoubtedly originated in the South Pacific.

Considering first the species in the North Atlantic---i.e.those found in one of the North Atlantic province, from the Brazilian around to the West African,---we find here 18 species, of which 6 are local, 2 are found in two adjacent provinces, 1 in three provinces, and the remaining 9 are found also in the South Pacific center.

Three of the 4 species found in the North Pacific are South Pacific forms.

These figures show clearly the origin of the genus Sertularia from an Antarctic source, and give us a striking example of the distribution of a group of hydroids from a common southern center.

Sertularia is most abundant in Zone I; about one-fourth of the species are found in Zone II, and almost none in any of the deeper zones. Since the tendency of shallow-water hydroids is to migrate farther and in greater numbers than their deep-water relatives, the comparatively scant distribution of Sertularia outside its main center can be explained only by assuming that Sertularia is one of the antarctic hydroids which, like the Campanulinidae of the north, was not forced into warmer waters by the Pleistocene glacier, its distribution having been more gradual because it is primarily a cold-water hydroid.

Thuiaria, the third genus in order of importance, with 40 species, has three principal centers, one including the Eastern North American and Arctic Atlantic provinces, and the other including Arctic and South Alaska; this indicates at once that Thuiaria is an arctic hydroid.

In the North Atlantic center, 10 of the 16 species are common to both the named provinces, and the other 6 are local. In the Alaskan center, 7 of the 13 species are common to both provinces, and 7 are common also to the North Atlantic center.

All species found elsewhere in the Atlantic Ocean are found also in the North, except three local forms, and one species (T.tubuliformis) which at present has a southern distribution. This species, however, is found in the West Indies, and is doubtless found north of this province.

Of the 30 species in the Pacific Ocean, 14 are found in the Alaskan center. Of the remaining 16, 1 is common to the Japanese and Arctic Asiatic provinces, 1 to Australia and Hawaii, and 14 are local, distributed as follows;- New Zealand (2); Australia (5); Japan (5); and Arctic Asia (2). It is easily concievable that most of the Japanese species, if not all, are of direct arctic origin, as two have already been shown to be; the cold Kamschatka current from the Bering Sea is the carrier. This would leave but 8 species of Thuiaria in the Pacific not connected with an arctic source. The arctic origin of Thuiaria, though not so distinctly shown as in the Atlantic, is nevertheless perfectly plain.

In depth, Thuiaria is equally abundant in the first two zones, and only a little less so in the third zone. It is thus readily exposed to the action of ocean currents, which have effected a wide distribution through the northern hemisphere and a more scattered distribution in the southern.

Diphasia, a genus of 25 species, is most abundant along the west and north-west coasts of Europe. Considering, then, the Continental and Arctic European provinces as the center, we find that in the entire Atlantic Ocean, 4 of the 8 species found outside these two provinces are found within them as well.

In the Pacific, 4 of the 7 species in the New Zealand-Australian regions are found also in the Atlantic, and one as far west as the Red Sea (E.African). In the Japanese province, 3 out of 4 species are local, and one is found in Hawaii. Two of the 4 Alaskan-Californian species are local, 1 is an Atlantic form, and one is Alaskan. Thus the fauna of the Australian region is undoubtedly related to that of the European, so far as Diphasia is concerned, while that of the rest of the Pacific is not. This may be explained by noting that no species of Diphasia have been recorded from the Patagonian, Magellanic, Peruvian, or Mexican provinces, and only 1 from the Brazilian; a migration south through the Bering Sea is thus perfectly plain, since migration around Cape Horn would certainly have left some traces in South

America, and migration through the Mascarene is most unlikely because of the predominance of west-flowing currents through the Indian Ocean.

Diphasia is most abundant in Zones II, III, and IV, and as many have been found in Zone V as in Zone I. It distribution must thus have been slow and unaffected by the agencies acting on shallow-water forms. Here again we find that practically all the species farthest from home live in the first and second zones.

Selaginopsis, a genus of 20 species, is the most strictly arctic genus yet discussed in the family Sertularidae. It is most abundant along the east coast of Siberia (Japanese) and in the two Alaskan provinces; only two local species are found south of the equator, one in New Zealand, and one at Kerguelen.

Seventeen of the 20 species are grouped within the Japanese-Arctic Asiatic-Alaskan area, and all the 5 species from the North Atlantic are also found in this center, except one local Arctic European form.

Most species of Selaginopsis live in the second zone of depth.

Selaginopsis is a good example of a holarctic genus, most of whose members are still in arctic waters. Its distribution into warmer waters has evidently just begun, as evidenced by the extensive northern distribution and the identity of Pacific and Atlantic groups.

Abietinaria, the last of the 6 major Sertularian genera, is made up of 20 species. It is practically confined to the North Pacific Ocean, to an even greater extent than Selaginopsis; only 2 species are found outside the North Pacific, and these are North Atlantic representatives of Pacific species.

In depth, Abietinaria is most abundant in the second and third zones, but of frequent occurrence down to 500 fathoms.

Like Selaginopsis, it is an arctic form whose distribution has only just begun.

****

An examination of the distribution charts of the 12 minor Sertularian genera will show that in most cases the distribution is either northern or southern, even though but few species are redorded. From these records and from those of the 6 major genera, we may tabulate the origins of the Sertularian genera as follows:-

Arctic:-	Species
Thuiaria	40
Diphasia	25
Selaginopsis	20
Abietinaria	20
Hydrallmania	4
5 genera,	109 species

Antarctic:-	Species
Sertularella	96
Sertularia	60
Pasythea	2
Dictyocladium	4
Idiella	1
Desmoscyphus	2
Staurotheca	3
Calamphora	1
Odontotheca	2
Thuiella	1
Lineolaria	2
Thyroscyphus	5
Stereotheca	1
13genera,	180 species

The large number of small genera in the antarctic group is made up almost entirely of forms very similar in every

respect to Sertularella and Sertularia, and were included by earlier writers in these two genera. It is only within the last two decades that taxonomists have placed them in separate genera after careful study of their characteristics, deciding that they are nevertheless direct linean descendants of the two major genera.

The 5 arctic genera are well-defined, and have no such direct descendants as have the two great antarctic genera. This is to be expected from what we know of the essentially arctic character of most of these 5 genera, their method of life and their probable period of migration.

The Sertularidae, in conclusion, are a family of bipolar origin, whose southern branch was the first to migrate and hence is the more numerous in genera and species and the more widely distributed. The distribution of the northern branch of the family has been retarded by the fact that the arctic group lived on the whole in deeper waters than the antarctic group. A comparison of the two groups with regard to depth shows this:-

By species:-

Zone	I	II	III	IV	V	VI	VII	VIII
Arctic	33	46	29	23	14	5	1	
Antarctic	93	56	35	16	19	5	3	1

By approximate percents:-

Arctic	30	42	22	21	13	5	1	
Antarctic	52	31	19	9	11	3	2	1

The antarctic group are most abundant in Zone I, and the arctic group in Zone II.

14. Plumularidae.

The Plumularidae are the last of the hydroid families under discussion, and are considered by most writers to be the most highly developed of all the hydroids. There are 32 genera and 307 species; this shows a considerably larger number of genera in relation to species than was the case in either the Campanularidae or the Sertularidae, the two families nearest the Plumularidae in size.

			Genera/species
Campanularidae	7 genera;	138 species	.041
Sertularidae	18 "	289 "	.062
Plumularidae	32 "	307 "	.104

Like the Sertularidae, which some authors consider the hidhest in the hydroid scale, the large majority (242) of species are contained within six major genera, which are:- Aglaophenia (88); Plumularia (79); Halicornaria (23); Cladocarpus (20); Lytocarpus (20); Antennularia and Nemertesia, two practically identical genera (19). These will be discussed in turn.

Aglaophenia, in number of species, is second only to Sertularella among all the hydroids. The genus attains its greatest development in the West Indies (28 sp.), with a center almost as important in the South Australian province. The groups in these two centers are practically distinct, only 3 species being common to both.

Considering first the species of Aglaophenia found in the North Atlantic Ocean, we find that of the 46 species recorded from this region, including the Brazilian and

Table #13.

PLUMULARIDAE.

Species.	Atlantic											Indian			Pacific										Antarctic	Bathymetrical in fms.
	Brazil. Pat.	W.I.	E.N.A.	Arc.Atl.	Arc.Eur.	Cont.	Med.	W.Af.	S.Af.	E.Af.	Terg.	Masc.	N.Z.	S.Aus.	N.Aus.	Ocean.	Jap.	Haw.	Arc.Pa.	Arc.Al.	S.Al.	Cal.	Mex.	Peru.	Magel.		
Acanthella:-																										
A.effusa(Busk)															+	+										-10-
Acanthocladium:-																										
A.huxleyi(Busk)																+										15-49
Acladia:-																										
A.africana(Marktanner-T.)									+																	-
Aglaophenia:-																										
A.acacia(Allman)			+					+		+																70-500
A.acanthocarpa(Allman)														+												-
A.adriatica(Babic)							+																			14
A.allmani(Nutting)	+	+													+	+										2-42
A.alopecura(Kirchenpauer)									+																	-
A.aperta(Nutting)		+																								194-200
A.apocarpa(Allman)		+																								29-116
A.arctuata(Lamouroux)									+																	-
A.armata(Bale)															+											70-80
A.attenuata(Allman)									+																	10-20
A.aurita(Busk)															+											27
A.bakeri(Bale)															+											-
A.banksii(Gray)														+												-
A.bellis(Thorneley)																+										-
A.bicuspis(Sars)								+																		80-100
A.bicornuta(Nutting)		+																								150-250
A.bilobidentata(Stechow)																	+									81
A.brevicaulis(Kirchenpauer)															+	+										0-10
A.calamus(Allman)	+															+										10-20
A.coarctata(Allman)																+										10
A.conferta(Kirchenpauer)									+																	-
A.constricta(Allman)		+																								30
A.contorta(Nutting)		+																								2-6
A.crenata(Fewkes)			+																							1242
A.cristifrons(Nutting)		+																								163
A.crucialis(Lamouroux)														+	+	+										-
A.decumbens(Bale)															+											80-100
A.delicatula(Busk)		+											+		+											0-25
A.dichotoma(Sars)							+		+																	0-10
A.diegensis(Torrey)																						+				1-7
A.divaricata(Busk)															+											80-320
A.dromaius(Allman)						+																				539
A.dubia(Nutting)	+	+																								6-100
A.elegans(Nutting)		+																								70-80
A.flowersi(Nutting)		+																								116
A.fusca(Kirchenpauer)									+																	-
A.gracillima(Fewkes)		+																								96
A.helleri(Kirchenpauer)						+	+																			0-1
A.heterodonta(Jäderholm)									+	+																55-60
A.huttoni(Kirchenpauer)												+														-
A.incisa(Coughtrey)												+														-
A.inconspicua(Torrey)																						+				5
A.insignis(Fewkes)		+																								262
A.integra(Sars)								+																		80-100
A.latirostris(Nutting)	+																					+				-
A.laxa(Allman)															+		+									38-98

| Species | | |

PLUMULARIDAE.

Species.	Atlantic: Brit. Bat.	W.I.	E.N.A.	Arc. Atl.	Arc. Eur.	Cont.	Med.	W. At.	S. At.	Indian: E. At.	Trop.	Mase.	Pacific: N.Z.	S. Aus.	N. Aus.	Ocean.	Haw.	Jap.	Arc. As.	Arc. Al.	S. Al.	Alt.	Mex. (S).	Peru.	Mag.	Antarctic	Bathymetrical in fm.
Aglaophenia(cont.):-																											
A.lendenfeldi(Bale)														+													—
A.ligulata(Kirchenpauer)									+																		—
A.lophocarpa(Allman)		+																					+				24-1181
A.macgillivrayi(Busk)																++											1-10
A.mamillata(Nutting)		+																									13
A.marginata(Ritchie)								+							+												0-1
A.minima(Nutting)	+	+																									"Sh.w."
A.minuta(Fewkes)		+	+																								"Sh.w"
A.nanella(Stechow)							+																				0-10
A.octocarpa(Nutting)																							+				—
A.parva(Pieper)	—																										—
A.parvula(Bale)														+													0-10
A.patagonica(d'Orbigny)	+																										"shore"
A.pelagica(Lamouroux)		+	+			+																					"fl."
A.pennatula(Ellis&Solander)						+			+																		"d.w."
A.perforata(Allman)		+						+				+															"fl."
A.perpusilla(Allman)		+																									34
A.pluma(Linnaeus)					+	+	+		+					+	?+	+							+				0-40
A.plumifera(Kirchenpauer)									+																		—
A.plumosa(Bale)														+													0-10
A.pusilla(Kirchenpauer)									+																		—
A.ramulosa(Kirchenpauer)		+												+													76-94
A.rathbuni(Nutting)	+																										—
A.reflexa(Pennington)						+																					—
A.rhyncocarpa(Allman)		+																									3-250
A.rigida(Allman)		+	+															+									9-116
A.robusta(Fewkes)		+																									88
A.rubens(Kirchenpauer)														+	+												0-20
A.savignyana(Kirchenpauer)		+					+			+																	—
A.schneideri(Borradaile)												+															24
A.septata(Ritchie)												+															-490-
A.septifera(Broch)							+																				-16-
A.simplex(d'Orbigny)		+																									"fl."
A.sinuosa(Bale)												+		+	+												25-38
A.squarrosa(Kirchenpauer)															+	+											0-20
A.struthionides(Murray)																						+	+				0-32
A.suensoni(Jäderholm)																		+									44
A.tenerrima(Kirchenpauer)																								+			—
A.tenuinoda(Borradaile)												+															28
A.tricuspis(McCrady)		+																									1-2
A.trifida(Agassiz)		+	+																								"bch."
A.tubulifera(Hincks)					+	+			+	+	+			+													15-122
A.urens(Kirchenpauer)															+	+	+										0-20
A.whiteleggi(Bale)															+			+									-81-
Glaophenopsis:-																											
A.distans(Nutting)		+																									352
A.hirsuta(Fewkes)		+																									229-440
A.verrilli(Nutting)			+																								1497-1740

Table (cont.)

Species.

Pleuria (cont.):-
Pleuria lendenfeldi (Bale)
Pleuria litoralis (Kirchenpauer)
Pleuria lophocarpa (Allman)
Pleuria mogellivrayi (Busk)
Pleuria pumilata (Hutting)
Pleuria purpurea (Nitsche)
Pleuria retusa (Hutting)
Pleuria rubrata (Perkes)
Pleuria rugosa (Stechow)
Pleuria scytocarpa (Hutting)
Pleuria serra (Thyer)
Pleuria spinula (Bale)
Pleuria tasmanica (d'Orbigny)
Pleuria vegasica (Lamouroux)
Pleuria ventricula (Hilgendorf)
Pleuria verticillata (Allman)
Pleuria virgula (Allman)
Plumularia (Linnæus)
Plumularia (Kirchenpauer)
Plumularia (Bale)
Plumularia (Kirchenpauer)
Plumularia (Kirchenpauer)
Plumularia (Hutting)
Plumularia (Pengington)
Plumularia (Allman)
Plumularia (Allman)
Plumularia (Jewkes)
Plumularia (Kirchenpauer)
Plumularia (Kirchenpauer)
Plumularia (Bale)
Plumularia (Kirchenpauer)
Plumularia (Torrey)
Plumularia (Nitsche)
Plumularia (Bruce)
Plumularia (d'Orbigny)
Plumularia (Bale)
Plumularia (Kirchenpauer)
Plumularia (Burrey)
Plumularia (Anderson)
Plumularia (Kirchenpauer)
Plumularia (Bale)
Plumularia (McCrady)
Plumularia (Agassiz)
Plumularia (Nutting)
Plumularia (Kirchenpauer)
Plumularia (Bale)

Polyphemopsis:-
Polyphemopsis (Hutting)
Polyphemopsis (Jewkes)
Polyphemopsis (Hutting)

PLUMULARIDAE.

Species.	Atlantic: Brax. Pat.	W.I.	E.N.A.	Arc. Atl.	Arc. Eur.	Cont.	Med.	W. Af.	S. Af.	Indian: E. Af.	Terr.	Mase.	Pacific: N.Z.	S. Aus.	N. Aus.	Ocean	Jap.	Haw.	Arc. As.	Arc. Al.	S. Al.	Cal.	Mex.	Peru.	Mag.	Antarctic	Bathymetrical in fms.
Antenella:-																											
A.allmani(Armstrong)												+															8-50
A.avalonia(Torrey)																						+					0-10
A.complexa(Nutting)																		+									30-138
A.quadriaurata(Ritchie)		+							+																	+	100-237
A.secundaria(Linnaeus)						+	+	+	+			+		+		+	+										4-270
A.siliquosa(Hincks)						+	+																				32-240
Antenellopsis:-																											
A.dofleini(Stechow)																	+										20-24
A.integerrima(Jäderholm)																	+										0-10
Antennopsis:-																											
A.annulata(Allman)		+																									107-283
A.distans(Nutting)		+																									115
A.hippuris(Allman)		+																									195-263
A.longicorna(Nutting)		+																									204
A.nigra(Nutting)		+																									121
A.scotiae(Ritchie)									+																		25
Antennularia:-																											
A.americana(Nutting)			+																								58-373
A.antennina(Linnaeus)			+	+	+	+	+	+					+				+										8-200
A.cylindrica(Bale)														+	+												5-7
A.decussata(Kirchenpauer)									+																		-
A.fasciculatis(Allman)									+																		100-150
A.geniculata(Nutting)		+																									273-441
A.hartlaubi(Ritchie)									+																		26
A.johnstoni(Kirchenpauer)									+																		-
A.pinnata(Nutting)		+	+																								86-100
A.perrieri(Billard)						+	+	+									+										6-483
A.profunda(Quelch)								+																			600
A.rugosa(Nutting)			+																								46
A.simplex(Allman)		+																									48-201
Callicarpa:-																											
C.gracilis(Fewkes)		+																									-
Calvinia:-																											
C.mirabilis(Nutting)		+																									270-440
Cladocarpus:-																											
C.carinatus(Nutting)		+																									273-440
C.compressus(Fewkes)		+																									114
C.cornuta(Verrill)			+	+																							103-572
C.dolichotheca(Allman)		+	+																								107-283
C.flexilis(Verrill)		+	+																								27-167
C.flexuosus(Nutting)		+																									940
C.grandis(Nutting)		+																									220-440
C.holmi(Levinsen)				+	+																						81-103
C.moebiusi(Schulze)					+																						135-217
C.obliquus(Nutting)		+																									200
C.paradisea(Allman)		+																									100-440
C.pectiniferus(Allman)							+																				172-900
C.pourtalesii(Verrill)		+	+		+	+																					90-300
C.septatus(Nutting)		+?	+																								48-430
C.sigma(Allman)		+				+																					22-222
C.speciosus(Verrill)			+	+	?																						-200
C.tenuis(Clarke)		+																									101
C.vancouverensis(Fraser)																						+					15-30
C.ventricosus(Allman)		+																									100

Table #13(continued)

PLUMULARIDAE.

Species.	Atlantic: Brak. Pat.	Atlantic: W.I.	Atlantic: E.N.A.	Atlantic: Arc. Atl.	Atlantic: Arc. Eur.	Atlantic: Cont.	Atlantic: Med.	Atlantic: W. Af.	Atlantic: S. Af.	Indian: E. Af.	Indian: Terg.	Indian: Masc.	Pacific: N. Z.	Pacific: S. Aus.	Pacific: N. Aus.	Pacific: Ocean.	Pacific: Jap.	Pacific: Haw.	Pacific: Arc. As.	Pacific: Arc. Al.	Pacific: S. Al.	Pacific: Cal.	Pacific: Mex.	Pacific: Pan.	Pacific: Mag.	Antarctic	Bathymetrical in fm.
Diplopteron:-																										
D.grande(Nutting)		+																								273-294
D.longipinna(Nutting)		+																								200-
D.quadricorne(Nutting)		+																								150-200
Gattya:-																										
G.humilis(Allman)	"North America."																									0-20
Halicornaria:-																										
H.ascidioides(Bale)															+											-
H.baileyi(Bale)															+											0-10
H.bryani(Nutting)																		+								213
H.expansa(Jäderholm)																	+									0-163
H.furcata(Bale)															+											20-100
H.gracicaulis(Jäderholm)									+	+		+				+	+									-60-
H.haswelli(Bale)															+	+										5
H.hians(Busk)												+				+	+	+								1-60
H.ilicistoma(Bale)															+											0-10
H.insignis(Allman)												+														-
H.ishikawai(Stechow)																	+									70-81
H.longicauda(Nutting)	+	+																								-34-
H.longirostris(Kirchenpauer)															+											-
H.pansa(Kirchenpauer)										+		+					+		+							60-163
H.prolifera(Bale)															+											0-10
H.ramulifera(Allman)						+																				640
H.roretzii(Marktanner-T.)																	+									0-325
H.saccaria(Allman)												+														-
H.setosa(Armstrong)												+														8-80
H.speciosa(Allman)		+																								4-56
H.superba(Bale)															+											-
H.variabilis(Nutting)		+																								"Sh.w."
Halicornopsis:-																										
H.elegans(Lamarck)												+			+											2-100
Halopteris:-																										
H.carinata(Allman)		+																								3-35
Hemicarpus:-																										
H.pennarius(Linnaeus)												+					+									3-26
Heteroplon:-																										
H.pluma(Allman)															+											38-40
Hippurella:-																										
H.longicarpa(Nutting)		+																								124

Table #13(continued)

PLUMULARIDAE.

Species.	Atlantic									Indian			Pacific									Antarctic	Bathymetrical in fms
	Brazil. Dist.	W.I.	E.N.A.	Arc. Atl.	Arc. Eur.	Cont.	Med.	W. Af.	S. Af.	E. Afr.	Iterg.	Masc.	N.Z.	S. Aus.	N. Aus.	Ocean.	Jap.	Haw.	Arc. As.	Arc. Al.	S. Al.	Cal.	Mex.	Mag. Peru.		
Lytocarpus:-																										
L.annandalei(Ritchie)												+														606
L.clarkei(Nutting)		+																								13-201
L.crosslandi(Ritchie)								+				+														—
L.curtus(Nutting)		+																								"Sh.w."
L.fasciculatus(Thorneley)												+														—
L.furcatus(Nutting)		+																								"Sh.w."
L.graeffei(Kirchenpauer)																+	+	+								40-325
L.grandis(Clarke)		+						+							+											5-339
L.hawaiiensis(Nutting)																		+								44-115
L.longicornis(Busk)															+	+	+									9-12
L.multiplicato-pinnata(Kirch.)								+?	+		+	+														- 9 -
L.patulus(Kirchenpauer)									+																	—
L.philippinus(Kirchenpauer)		+	+	+				+			+	+			+	+	+	+	+?							1-8
L.phoeniceus(Busk)							+					+			+	+	+	+	+							4-287
L.plumosus(Thorneley)												+														—
L.racemiferus(Allman)	+																									10-20
L.ramosus(Fewkes)		+																								95
L.similis(Nutting)																		+								213
L.singularis(Billard)																+	+									—
L.spectabilis(Allman)															+	+										8-10
Monostaechas:-																										
M.fisheri(Nutting)																		+								56-130
M.quadridens(McCrady)		+	+					+				+			+	+	+	+								4-296
Monotheca:-																										
M.margaretta(Nutting)		+	+																							0-10
M.obliqua(Johnston)							+	+							+	+										0-2
Nemertesia:-																										
N.ciliata(Bale)															+											60-80
N.disticha(Heller)								+																		0-10
N.intermedia(Kirchenpauer)									+																	—
N.japonica(Stechow)																	+									250
N.norvegica(G.O.Sars)						+	+	+																		50-250
N.ramosa(Lamouroux)		+					+	+	+	+																54-122
N.tetrasticha(Meneghini)								+	+																	0-10
Nuditheca:-																										
N.dalli(Clarke)																				+						"bch."
Ophinella:-																										
O.parasitica(Hincks)						+																				80-100
Plumularia:-																										
P.abietina(Allman)			+																							150
P.aglaophenoides(Bale)															+	+										- 25 -
P.alata(Bale)														+	+											—
P.alicia(Torrey)																					+					5-25
P.alleni(Nutting)						+																				—
P.altitheca(Nutting)		+																								270-280
P.annuligera(Quelch)									+																	—
P.attenuata(Allman)		+							+																	65-576
P.australis(Kirchenpauer)															+											0-10
P.badia(Kirchenpauer)																+	+									7-8
P.bonneviae(Bonnevie,n.n.)						+	+																			55-444
P.buskii(Bale)													+		+			+								0-10

Table #13(continued)

PLUMULARIDAE.

Species	Atlantic. Brazil. Pat.	W.I.	E.N.A.	Arc. Atl.	Arc. Eur.	Cont.	Med.	W. Af.	S. Af.	Indian E. Af.	Terg.	Masc.	N.Z.	S. Aus.	N. Aus.	Ocean.	Jap.	Haw.	Arc. As.	Arc. Al.	S. Al.	Cal.	Mex.	Peru.	Magr.	Antarctic	Bathymetrical In fm.
Plumularia(cont.):-																											
P.caliculata(Bale)														+													—
P.campanula(Busk)														+	+												20-45
P.catharina(Johnston)		+			+	+																					50-270
P.caulitheca(Fewkes)		+																									273-416
P.clarki(Nutting)		+																									175-182
P.compacta(Thorneley)																+											—
P.compressa(Bale)														+													0-10
P.cornuta(Bale)														+	+												15-20
P.corrugata(Nutting)																		+			+	+					70-130
P.curvata(Jäderholm)	+																								+		—
P.delicata(Nutting)																		+									50-495
P.dendritica(Nutting)		+																									"sh.w."
P.diaphana(Heller)		+	+			+	+	+		+						+											0-576
P.dolichotheca(Allman)																+											10
P.echinulata(Lamarck)						+	+		+													+					0-1
P.filicaulis(Kirchenpauer)														+											+		1-20
P.filicula(Allman)		+																									179-440
P.flabellum(Allman)																+											50-75
P.flexuosa(Bale)														+													—
P.floridana(Nutting)		+																									"fl."
P.frutescens(Ellis&Solander)					+	+	+		+		+																5-100
P.gaimardi(Lamouroux)									+																		—
P.geminata(Allman)		+																									30-352
P.glacialis(Hicksor&Gravely)																										+	100
P.goodei(Nutting)																					+	+					1-d.w.
P.habereri(Stechow)																	+										82
P.halecioides(Alder)						+	+	+		+					+							+					0-3
P.hertwigi(Stechow)																	+										8-11
P.hyalina(Bale)															+												0-10
P.groenlandica(Levinsen)				+																							—
P.inermis(Nutting)		+	+																								—
P.insignis(Allman)			+																								150-310
P.jordani(Nutting)																			+								79-130
P.lagenifera(Allman)									+								+					+	+				1-20
P.liechtensterni(Marktanner-T.)								+																			—
P.macrotheca(Allman)			+																								450
P.magellanica(Hartlaub)																								+	+		1-2
P.megalocephala(Allman)			+																			+					14-352
P.milleri(Nutting)																+		+									-95-
P.multinoda(Allman)														+													—
P.obconica(Kirchenpauer)															+												—
P.oligopyxis(Kirchenpauer)																								+	?		—
P.palmeri(Nutting)																						+	+				—
P.paucinoda(Nutting)			+																								121
P.pinnata(Linnaeus)						+	+	+		+																	-50
P.plumularioides(Clarke)																					+	+					8-25
P.procumbens(Spencer) j															+												-80-
P.profunda(Nutting)			+																								270-440
P.pulchella(Bale)															+												0-10
P.ramsayi(Bale)															+	+											5-25
P.scabra(Lamarck)																+	+										0-10
P.setacea(Ellis)			+			+	+	+	+	+				+	+	+		+	+			+	+		+		3-106
P.setaceoides(Bale)				+											+												0-10

PLUMULARIDAE.

Species	Atlantic: Brd's Pat.	Atlantic: K.I.	Atlantic: E.N.A.	Atlantic: Arc. Atl.	Atlantic: Arc. Eur.	Atlantic: Cont.	Atlantic: Med.	Atlantic: W. Af.	Atlantic: S. Af.	Indian: E. Af.	Indian: Trop.	Indian: Masc.	Pacific: N.Z.	Pacific: S. Aus.	Pacific: N. Aus.	Pacific: Ocean.	Pacific: Jap.	Pacific: Haw.	Pacific: Arc. As.	Pacific: Arc. Al.	Pacific: S. Al.	Pacific: Cal.	Pacific: Mex.	Pacific: Peru.	Pacific: Mag.	Antarctic	Bathymetrical in fm.
Plumularia(cont.):-																											
P.siliquosa(Hincks)						+	+																				-240-
P.similis(Hincks)						+	+																	+			0-458
P.spinulosa(Bale)													+	+													0-10
P.stylifera(Allman)									+																		100-150
P.sulcata(Lamarck)														+													25-80
P.tuba(Kirchenpauer)									+																		—
P.tubulosa(Bale)														+													—
P.turgida(Bale)													+														—
P.unilateralis(Ritchie)									+																		25
P.variabilis(Quelch)								+																			500
P.virginiae(Nutting)																						+					1-10
P.warreni(Stechow)									+																		—
P.wattsi(Bale)														+													—
Polyplumularia:-																											
P.armata(Nutting)		+																									270
P.flabellata(Sars)					+	+																					80-222
Pycnotheca:-																											
P.mirabilis(Allman)									+					+			+					+					38-98
P.producta(Bale)														+													—
Schizotricha:-																											
S.bifurca(Hartlaub)																										+	250
S.dichotoma(Nutting)		+																									200
S.gracillima(G.O.Sars)			+			+	+																				1-200
S.multifurcata(Allman)																	+										75
S.parvula(Nutting)		+																									352
S.tenella(Verrill)			+																								0-13
S.unifurcata(Allman)												+															10-100
Sciurella:-																											
S.indivisa(Allman)															+												5-16
Streptocaulus:-																											
S.pulcherrimus(Allman)								+																			100-500
Thecocarpus:-																											
T.benedicti(Nutting)		+																									270-440
T.bispinosus(Allman)		+																									156-200
T.brevirostris(Busk)												+		+	+	+											-27-
T.distans(Allman)		+																									283
T.formosus(Busk)									+				+	+	+	+											—
T.myriophyllum(Linnæus)			+			+	+	+	+	+																	12-364
T.niger(Nutting)																	+	+									7-163
T.normani(Nutting)		+																									440
T.phyteuma(Kirchenpauer)																+											—

West African provinces, only 12 are not reported from the central area covered by the Brazilian, West Indian, and Eastern North American provinces. Seven of the 12 are local species, and 4 are South African, a relation of considerable significance. There are but 4 species in the arctic region of the Atlantic, and the sole occurrence of 3 of these is the previously mentioned discovery of 3 species of Aglaophenia in a "warm spot" off the coast of Norway. Aglaophenia is thus a warm-water genus, and the scarcity of representatives in the higher latitudes of the North Atlantic shows at once that it is not of arctic origin.

Centering about South Africa is a group of Aglaophenias, 13 in number, whose affinities lie neither with the West Indian nor the Australian faunas. Not one South African species is found in the West Indies, though 4 are found elsewhere in the North Atlantic. Similarly, but 1 South African species is found in the South Australian province, though 1 is found in New Zealand and 1 in the East African.

There is a significant absence of Aglaophenia from the coasts of South America, and except for the Brazilian province, which lies adjacent to the West Indies, there are only 2 local species along the entire coast.

Turning to the Pacific, we find there 39 species, of which 24 are found within the Australian-New Zealand area. No representative of the genus has been found north of Japan and Puget Sound.

In the Mascarene province 8 species are found, of which 2 are found also in Australia and 2 in the Atlantic Ocean; 5 are local.

In depth, Aglaophenia lives mostly in Zone I; the considerable numbers in Zones II and III are nearly all isolated records of local species. It would thus be fairly exposed to the action of ocean currents.

We have here three regions, Australian, South African, and West Indian, whose species are practically distinct, and yet we must believe that the migration has followed this path. Reasons for this are seen in the dearth of arctic and of South American species and in the connection, even though slight, which the fauna of the Mascarene makes between those of the Atlantic, South African, and South Australian. Furthermore, it is at once apparent that the West Indies were not populated from the antarctic around Cape Horn without leaving any traces of Aglaophenia south of Brazil. The only course open to us is to believe that the genus had Australia as its first center, that the West Australian and the Equatorial Currents caused the distribution to be toward the west, through the Mascarene and South African, and that the Benguela and South Equatorial Currents carried the first representatives across to the coast of Brazil and the West Indies, where, in warm waters and otherwise favorable environment, development and differentiation have proceeded at a rapid rate, until we find at present what appears to be the center of a group of

tropical hydroids in the West Indies. Nutting and a number of other authors consider Aglaophenia a tropical genus, a belief based only on its abundance in the tropics. But if this is true, how could it have spread from there to Africa and Australia? Surely not around Cape Horn, and ocean currents around the Cape of Good Hope would not have permitted such a migration. The West Indian representatives of the genus are tropical in habits by this time, but the ancestral Aglaophenias must have come from a South Pacific, and ultimately, an antarctic center.

To account for the distinct characters of the species found in the three centers mentioned above, we need only remember that the exceedingly great period of time necessary to effect the notable specialization which is found in the structure of Aglaophena and all other Plumularians works also to differentiate closely allied forms into separate species, and that here the time element is the principal factor.

Plumularia, the second major genus, contains 79 species. It is most abundant in 4 regions:- Australia, the West Indies, Europe,(and the Mediterranean), and California; and here, as before, we find a large measure of separation between the species inhabiting these regions.

In the Atlantic Ocean, only 3 species are common to the West Indies and Europe; the affinities of the European group are more with the African fauna, the Continental province having 8 species in common with the Mediterranean, 3 with

the West African, 3 with the SouthAfrican, and 3 with the East African. The 1 species from Kerguelen is found also in Europe.

In the Pacific, there are 48 species of Plumularia. Of these, 28 are found within the Australia-New Zealand area. 27 species are found outside this center, 7 of which are found in the center as well. Of the remaining 20, 8 are local, 5 are found in 2 or more provinces in the North Pacific, 2 are found in the Nagellanic-Patagonian region, and 5 are found in the North Atlantic Ocean. It is worthy of note that 3 of the 5 species common to both oceans are also found in such intermediate provinces as the Australian, Mascarene, East African and South African, but that only the most cosmopolitan species of all, P. setacea, is reported from South America (Peruvian).

One of the 2 Mascarene species is Australian and the other is cosmopolitan (P.setacea.)

In depth, Plumularia predominates in Zone I, with a considerable number in the next three zones.

To determine the probably course of migration of Plumularia, we have essentially the same facts to work with as were seen in the study of Aglaophenia, namely:- a) a center in Australia and another in the West Indies, practically distinct from each other; b) very few species in South America as contrasted with a fairly continuous chain from Australia to the West Indies and the North Atlantic via South Africa; c) favorable currents for a migration along the latter route. Thus, contrary to the assumption of

many, Plumularia arose, not in the tropics, but in the antarctic, with Australia as its first real center, the North Atlantic being populated by the same currents as carried Aglaophenia over a similar course. The distribution in the Pacific is explicable by the ocean currents found there.

Halicornaria, a genus of 23 species, is plainly of antarctic origin. The Australian-Oceanic area contains 12 species, the Japanese 3 local species and 2 belonging to the first region, the Hawaiian has 1 Oceanic and 1 local species, and the rest of the Pacific Ocean none. There are 6 species in the Mascarene, of which 3 are found also in the South Pacific center and 3 are local. The 2 East African and South African species also come from the South Pacific. The 4 Atlantic forms are all local, as might be expected.

Halicornaria is primarily a genus of Zone I, but is found almost as frequently in Zones II and III.

We have here a clear case of incipent migration from an Australian center. It well demonstrates what must have been the earlier stages in the migrations of Plumularia and Aglaophenia.

Cladocarpus, in the light of what we have already seen regarding the antarctic origin of the first three genera, presents a marked change, for not one of its 20 species is found south of the equator. All but 2 are confined to the North Atlantic Ocean, and 13 species are found in a center in the West Indies. There are 6 Eastern North American species,

of which 4 are also found in the West Indies. Four of the 8 species found elsewhere are found also in one of these two provinces. Only two species are found in the Pacific; the single Japanese species is recorded from the Continental and the Arctic European, and the one Alaskan form is local.

There is no recourse but to believe Cladocarpus a genus of arctic origin, and this belief is strengthened by the fact that no less than 6 species are found within arctic provinces. The migration from arctic waters must have been during a very early period, to have effected the change which has made Cladocarpus into an essentially tropical hydroid at present. The natural question then arises: If Cladocarpus has been migrating for a long time, why has it not yet been carried beyond the North Atlantic? The answwer to this is seen in a study of the depth distribution, which shows that Cladocarpus is most abundant in Zones IV and V, or between 100 and 500 fathoms' depth, and practically below the principal influence of ocean currents.

Lytocarpus is a genus of 20 species, and reproduces the distribution of Plumularia and Aglaophenia. There are 6 species in the Australian, Mascarene, and West Indian, with only 2 common to the first and second, 1 common to the second and third, and 1 to the first and third. Three Mascarene species, however, are found in the Atlantic, making the connection a little more certain. There are no South American species except 2 in the Brazilian. Practically all

the Pacific species belong to the Australian-Oceanic group.

Lytocarpus, like Plumularia and Aglaophenia, is most abundant in Zone I, indicating that ocean currents are the principal agents in distribution; like these two also it arose in the Australian and was carried north-east through the Pacific and west and north into the Atlantic to the limits of its present distribution.

Antennularia and Nemertesia are very closely allied, and have for a long time been considered as belonging to the same or different genera, according to the individual writer. Antennularia, as outlined by Stechow, includes 12 species, and Nemertesia 7.

Of the 19 species recorded, only 5 have been found outside the Atlantic Ocean, 2 in Australia, 2 in Japan, and 1 in New Zealand and Japan. Three of these are local species. In the Atlantic Ocean, 12 of the 17 species are local. The presence of 2 Atlantic species in the Pacific and not in the southern hemisphere indicates a common arctic source, and we may reasonably assume that the two genera, Antennularia and Nemertesia, had their origin in arctic waters.

In depth, they predominate in Zones III, IV, and V. This may help to account for the comparatively small distribution in relation to the long time which must have been necessary to permit such a widespread differentiation into species.

We have remaining 25 genera and 58 species, all scattered and mostly local. The 19 genera of only 1 or 2 species each demonstrate the tendency of species to diverge into separate genera after long periods of development, and furnish a strong argument for the seniority of the Plumularidae. It will be noticed also that the depth record of these minor genera shows the effect of migration away from the continental shelves by indicating as many forms in Zones Iv and V as in Zones I and II.

While it is difficult in some cases to judge whether a genus was of arctic or antarctic origin, the following table indicates the nearest possible approach to accuracy in that respect with the data at hand:-

Arctic:-	Species	Antarctic:-	Species
Antennularia	12	Plumularia	79
Nemertesia	7	Antennopsis(?)	6
Schizotricha	7	Monostaechas	2
Polyplumularia	2	Antenella	6
Monotheca	2	Calvinia	1
Nuditheca	1	Diplopteron	3
Antenellopsis	2	Hippurella	1
Cladocarpus	20	Callicarpa	1
Ophinella	1	Halopteris	1
9 genera,	54 sp.	Thecocarpus	9
		Aglaophenia	88
		Aglaophenopsis	3
		Lytocarpus	20
		Halicornaria	23
		Pycnotheca	2
		Halicornopsis	1
		Streptocaulus	1
		Hemicarpus	1
		Acladia	1
		Heteroplon	1
		Sciurella	1
		Acanthocladium	1
		22 genera,	252 sp.

There is no definite record for Gattya humilis(Allman), which is reported from "North America."

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SECTION V. Summary.

Factors in distribution:-

Physical conditions:-

Salinity:- Salinity is of little importance in governing the distribution of the hydroids. The amount of salt in normal sea-water is about 35 parts per thousand, varying between 32 and 40 parts. There is little variation anywhere except close to the shores, where salinity is generally lower. Hydroids have been classed as euryhaline and stenohaline, which are able to stand respectively much or little variation in salinity, but since each hydroid group contains many examples of both, salinity has little effect on either structure or distribution. Regarding the fresh-water hydroids, the almost universal opinion is that they have either migrated from the sea into fresh and brackish water or that they have been carried there, because of the small number of such hydroids and the large measure of intergradation between fresh- and salt-water species in the salinity of their habitats.

Pressure:- Pressure is of no discernable effect on either the structure or distribution of the hydroids.

Light:- The photic zone, extending down to a depth of 500 fathoms, by no means limits the bathymetrical distribution of the hydroids. Below the photic zone, phosphorescent light plays an important part in attracting food. Experimentally, little has been done to show the direct

SECTION V. Summary.

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Pressure:- Pressure is of no discernable effect on either the structure or distribution of the Hydroids.

Light:- The photic zone, extending down to a depth of 600 fathoms, by no means limits the bathymetrical distribution of the Hydroids. Below the photic zone, phosphorescent light plays an important part in attracting food. Experimentally, little has been done to show the direct

effect of light on hydroids, and we may make only the general statement that since hydroid life is more abundant within than below the photic zone, light is an essential part of the ideal environment for hydroid life, though it is not indispensable.

Temperature:- There is a considerable seasonal variation in the ocean temperature, and some hydroids endure changes of 70 degrees F. or more. There is, however, no seasonal variation in distribution attending these changes in temperature. The life of hydroids depends largely on the temperature of the water, since all marine animals and plants have a maximum range of favorable and of endurable temperature. The marked similarity between the littoral and abyssal faunsa of polar waters and between polar littoral and tropical and temperate deep-sea faunas has been the subject of some comment, as indicating a repetition among marine animals of Humboldt's Law, but this has never been fully discussed.

Certain groups of hydroids live at present in polar, temperate, or tropical waters, or in all three. Their origin was in polar waters; this belief is generally accepted now for the reasons that the hydroids are nearly all temperate or polar inddistribution and reach their maximum development in cold waters, and that such scattered geologic evidence as is available points toward an even

effect of light on hydroids, and we may make only the general statement that since hydroid life is more abundant within than below the photic zone, light is an essential part of the ideal environment for hydroid life, though it is not indispensable.

Temperature:- There is a considerable seasonal variation in the ocean temperature, and some hydroids endure changes of 20 degrees F. or more. There is, however, no seasonal variation in distribution attending these changes in temperature. The life of hydroids depends largely on the temperature of the water, since all marine animals and plants have a maximum range of favorable and of endurable temperature. The marked similarity between the littoral and abyssal faunas of polar waters and between polar littoral and tropical and temperate deep-sea faunas has been the subject of some comment, as indicating a repetition among marine animals of Humboldt's law, but this has never been fully discussed.

Certain groups of hydroids live at present in polar, temperate, or tropical waters, or in all three. Their origin was in polar waters; this belief is generally accepted now for the reasons that the hydroids are nearly all temperate or polar in distribution and reach their maximum development in cold waters, and that such scattered geologic evidence as is available points toward an even

more northerly and southerly distribution than now exists. During the Tertiary, polar waters were much warmer, and the hydroids grew up in polar regions, from which a large number, unable to stand the sudden drop in temperature, were driven by the arctic and antarctic glaciers of the Pleistocene; the only hydroids left in polar waters were those able to endure the extreme cold, and these today constitute our arctic and antarctic groups. The hydroids which were forced into warmer waters have continued their spread, both horizontally and vertically, through all the waters of the earth; horizontal migration has been aided by ocean currents, while the slower vertical migration has been due to the natural spread of animals through a favorable region. In some cases there has been a secondary horizontal spread toward the poles.

In general, hydroids accustomed to constant low temperature have no free medusa-stage, and it is believed that the inability of medusae to live in very cold waters is responsible for the early migration of medusa-bearing forms into warmer water. Further, medusae are seldom found below the mud-line (about 100 fathoms), indicating a restricted distribution for all medusa-bearing hydroids. Forms living below the mud-line are more hardy, since the water at that depth is consistently colder. In temperate waters, medusae are produced only during the warm season, and in tropical waters throughout the year, indicating that hydroids are limited in their range by the temperature during the breeding-season.

Temperature is further responsible for the greater variety and numbers among present tropical hydroids, because of the applicability of Van t'Hoff's Law to biochemical reactions.

There is little ground for the early belief in an archaic, abyssal fauna covering the whole world at great depths.

Movements of Water:- Agitation of the water develops environmental variations, and although these are not constant if quiet is restored, environmental forms are doubtless maintained by continuous activity of the waves.

So few hydroids are restricted to the tidal zone, that the action of the tides on either structure or distribution is negligible.

Ocean currents are the most important single means of spreading hydroids from their original centers; they have been of great effect by carrying medusae and planulae, since the life-cycle of all hydroids includes one or both of these free-swimming forms. Currents carry medusae much more readily than planulae because of their greater size, but since temperature places such limits on the favorable environment for a medusa, the slow, steady action of currents on the planulae is thought to be of more far-reaching importance, and practically all cosmopolitan hydroids have no free medusa-stage. Currents also transport materials

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Movements of Water:- Agitation of the water develops environmental variations, and although these are not constant if quiet is restored, environmental forms are doubtless maintained by continuous activity of the waves.

So few hydroids are restricted to the tidal zone, that the action of the tides on either structure or distribution is negligible.

Ocean currents are the most important single means of spreading hydroids from their original centers; they have been of great effect by carrying medusae and planulae, since the life-cycle of all hydroids includes one or both of these free-swimming forms. Currents carry medusae much more readily than planulae because of their greater size, but since temperature places such limits on the favorable environment for a medusa, the slow, steady action of currents on the planulae is thought to be of more far-reaching importance, and practically all cosmopolitan hydroids have no free medusa-stage. Currents also transport materials

to which hydroids are attached, and may even carry the hydroids themselves, in a few isolated instances.

Nature of base of attachment:- Hydroids are attached mainly either to plants or to fixed physical structures. The most abundant hydroid life is within the zone of algae, down to 50 fathoms (Zones I and II.) Certain hydroids are often associated with red or with brown algae, sometimes exclusively. The large masses of algae which are transported, often for great distances, by ocean currents, carry with them numbers of hydroids, and some islands have received their hydroids almost entirely in this way.

Of the physical structures, rocks and stones bear the largest number of hydroids; sand, gravel, and mud support very few.

Molluscan shells are of great importance, and hydroids also grow on other hydroid stems, live molluscs, worm-tubes, bryozoa, ascidians, sponges, corals, crustaceans, and fishes.

A favorable base is essential for the welfare of a colony, and hence is one of the most important conditions affecting distribution.

Biological Conditions:-

Hydroids are advantageous to other organisms in that:-

a) They serve as food for nudibranchs, gastropods, fishes, etc. b) They afford a base of attachment for bryozoa, algae, protozoa, diatoms, other hydroids, etc. c) They give concealment to structures on which they grow.

Hydroids are disadvantageous to no animals except those on which they feed. Thus they are of indirect, but of none

the less great, benefit to other organisms, and, in the long run, to man.

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Taxonomic Distribution:-

Clavidae:- 13 genera, 29 species. Confined largely to the Continental and Mediterranean provinces and to Zone I. The large proportion of genera to species indicates an early and long-continued migration, and the original source was arctic. The most important fresh-water genus, Cordylophora, belongs to this family.

Corynidae:- 16 genera, 61 species. An arctic family, centering now about the North Atlantic, mostly in Zone I. Though the Clavidae prefer algae as bases of attachment, the Corynidae grow more abundantly on rocks, and are therefore not distributed by transportation of their bases.

Hydrolaridae:- 1 genus, 1 species. The single species, Lar sabellarus (Gosse), is local in the British Isles, and lives in Zone I.

Bougainvillidae:- 16 genera, 95 species. An arctic family, containing a large number of holarctic forms. Distribution is widespread, confined mostly to Zone I. Two fairly distinct groups in Atlantic and Pacific indicate a long-continued period of migration.

Pennaridae:- 6 genera, 12 species. An arctic family, centering at present in the Continental-Mediterranean region, whence it has spread to the West Indies. It is entirely within Zone I.

Eudendridae:- 1 genus, 39 species. Eudendrium centers at present both in the North Atlantic and North Pacific, practically all forms found elsewhere belonging to these two regions. Though of arctic origin, it has been carried into the Mascarene and Antarctic, a condition for which the shallow-water habit of the genus, which lives mostly within Zone I, is responsible.

Tubularidae:- 11 genera, 62 species. Except for the cosmopolitan Tubularia, the family is practically confined to the North Atlantic, and is of arctic origin; there are still many holarctic forms. Bathymetrical distribution is mainly within Zone I.

****

A review of the Gymnoblastea shows certain conditions common to all:- a) Arctic origin; b) Distribution mainly within the North Atlantic; c)Large numbers of local species; d) Large proportion of families to genera, and of genera to species---i.e. wide differentiation; e) Bathymetrical distribution mainly within Zone I.

We may conclude that the Gymnoblastea are subject to greater variation than the Calyptoblastea, and that their migration, on the whole, is of longer duration than that of the Calyptoblastea.

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Halecidae:- 6 genera, 66 species. Connecting link between Gymnoblastea and Calyptoblastea. Halecium is of arctic origin,

and has distinctly related groups in the North Atlantic and North Pacific.. Most of the other genera are found within or south of the tropics, and are direct descendants of Halecium. The family is more abundant in Zones II, III, and IV than are the Gymnoblastea, a condition which tends to retard distribution.

Campanulinidae:- 9 genera, 33 species. A distinctly arctic family, most abundant in the North Atlantic and North Pacific, which two groups are closely related. Very few representatives are now in the tropics, and normal distribution has been retarded by deep-water habits of the family.

Lafoeidae:- 11 genera, 74 species. An arctic family, centering at present in the North Atlantic and North Pacific, the two groups less related than the same groups of the Campanulinidae. Lafoea is an Atlantic species, while Hebella, Zygophylax, and Bonneviella are Pacific species; Grammaria is divided. The geographical range has been extended into the tropics in only a few cases, and the family lives in even greater depths as a whole than either the Campanulinidae of the Halecidae.

Campanularidae:- 7 genera, 138 species. Campanularia (62 species) is most abundant in the South Alaskan, Eastern North American, Continental, and Mediterranean provinces, all linked by common species, and indicating arctic origin by the large number of holarctic species. Tropical and southern forms belong almost wholly to the northern centers. The

genus is most abundant in Zone I, and is seldom found below 100 fathoms.

Clytia (26 species) is equally abundant in 5 widely separated provinces, but a large proportion of the species are referable to a center in the North Atlantic. Clytia lives almost wholly in Zone I.

Obelia (27 species) is more widely distributed than Clytia, and has developed Atlantic and Pacific groups. It lives mostly in Zone I. Because of its wider distribution and the fact that it bears medusae while Clytia and Campanularia do not, Obelia is thought to have been the first major genus of the family to migrate into warmer waters.

The family is of arctic origin, with the exception of 1 genus, Silicularia, and is widely distributed. The small number of genera in relation to species indicates a shorter period of migration than that of the Gymnoblastea.

Synthecidae:- 3 genera, 16 species. Connecting link between Campanularidae and Sertularidae. The family centers about Australia, and is of antarctic origin; depth distribution is mostly within Zones I and II.

Sertularidae:- 18 genera, 289 species. Sertularella (96 species) is abundant in 5 widely separated regions, but includes a large number of local species and has only 3 cosmopolitan species. The five centers are practically distinct from one another, but the antarctic origin of the genus is shown by the small number of purely northern species,

and its outward spread from the original Australian center can be traced along the paths of the ocean currents. Its migration has been of long duration. In depth, Sertularella lives mostly within Zones I and II.

Sertularia (60 species) also centers about Australia, and its West Indian center was populated from Australia. It is confined mainly to Zone I, and because its distribution is much narrower than that of Sertularella, it probably took place more recently.

Thuiaria (40 species) comes from an arctic source, and its present centers are eastern and western North America. Most of the species found elsewhere belong to one of these centers. Thuiaria is evenly distributed through Zones I, II and III.

Diphasia (25 species) is also an arctic genus, with its main center along the northwest coast of Europe, and a smaller one in the North Pacific. Migration has been slow, since the genus is most abundant in Zones II, III, and IV.

Selaginopsis (20 species) is a typical holarctic genus, and its spread into temperate waters has only just begun. It is most abundant in Zone II.

Abietinaria (20 species) is an arctic genus, practically confined to the North Pacific. It is most abundant in Zones II and III.

Five genera and 109 species are of arctic origin, all perfectly distinct from one another. Thirteen genera and

180 species are of antarctic origin, and include Sertularella and Sertularia and a large number of minor genera directly descended from them. In general, the arctic forms live in deeper water than the antarctic forms, which helps to explain the more limited distribution of the former.

Plumularidae:- 32 genera, 307 species. Aglaophenia (88 species) centers about two regions, Australia and the West Indies, and nearly all northern forms are referable to one of these centers. Because of the absence of Aglaophenia in South America south of Brazil, and the west-flowing currents through the Indian Ocean, the genus is thought to have been carried from the Australian center; connections can be traced through the Mascarene and South African. It is thus an antarctic genus. Aglaophenia is most abundant in Zone I, and would tend to change rapidly on being introduced into warm waters.

Plumularia (79 species) is also most abundant in Zone I, and exhibits the same plan of distribution as Aglaophenia.

Halicornaria (23 species) is in the early stages of the same migration. Its center is around Australia, and most existing species are referable to this center; the westward spread has not passed the Mascarene to any great extent. Depth distribution shows Halicornaria nearly as abundant in Zones II and III as in Zone I.

Cladocarpus (20 species) is found mostly in the North Atlantic, entirely north of the equator. Its center is the West Indian province, and it includes several arctic species. It is thus of arctic origin, and is most abundant in Zones IV and V.

Lytocarpus (20 species) is most abundant in Zone I, and reproduces on a smaller scale the distribution of Aglaophenia and Plumularia.

Antennularia and Nemertesia (19 species) are of arctic origin, and have many species common to North Atlantic and North Pacific. Most of the species are local, and the present limited range is probably due to the fact that the genera are most abundant in Zones III, IV, and V.

The remaining genera of the Plumularidae are small, local, and as abundant in Zones IV and V.as in Zones I and II. This shows the natural course taken during the differentiation of isolated species of a genus into separate genera, during both horizontal and vertical distribution.

Nine genera and 54 species are of probably arctic origin; twenty-two genera and 252 species came from the antarctic. The Plumularidae are at once the oldest and the most highly specialized of all the hydroid families.

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SECTION VI. Conclusion.

All of the statements made heretofore regarding the distribution of a genus or a family have been made with the full realization that for a group of animals like the hydroids, which are collected mainly by means of the dredge and the tangle, any such statements are rendered inaccurate by the extremely uneven distribution of dredging stations in all parts of the world and at all depths. The inaccuracy is unavoidable, since the statements are made from the study of all the existing records, and it will require an enormous amount of further dredging and collecting to alter substantially the general conclusions presented in this paper.

The one thing left to be done is to summarize the geographical and bathymetrical distribution figures for the whole group of hydroids, keeping in mind the fact that while the actual figures given are necessarily inaccurate, they will indicate what is undoubtedly the truth for the group as a whole. The figures given below represent the total hydroid species found by present records within each of the 27 provinces and the 10 zones of depth.

We see at a glance that the hydroids are preeminently a cold-water group, having their present center in the North Atlantic. Of the depth zones, Zone I contains by far the richest hydroid fauna. The physical and biological conditions surrounding them have been discussed in preceding sections.

Beyond this, no general statement can be made for the distribution of the whole group.

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Beyond this, no general statement can be made for the distribution of the whole group.

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Province:-	Total Species:-
Atlantic Ocean:-	
Patagonian	49
Brazilian	29
West Indian	189
Eastern North American	184
Arctic Atlantic	114
Arctic European	157
Continental	229
Mediterranean	152
West African	87
South African	82
Indian Ocean:-	
East African	39
Kerguelen	22
Mascarene	110
Pacific Ocean:-	
New Zealand	81
South Australian	160
North Australian	80
Oceanic	78
Japanese	144
Hawaiian	48
Arctic Asiatic	51
Arctic Alaskan	57
South Alaskan	159
Californian	88
Mexican	19
Peruvian	47
Magellanic	19
Antarctic Ocean:-	44

Zone of depth:-	
I. 0-20 fm.	611
II. 20-50 fm.	318
III. 50-100 fm.	270
IV. 100-200 fm.	213
V. 200-500 fm.	160
VI. 500-1000 fm.	30
VII. 1000-1500 fm.	11
VIII. 1500-2000 fm.	6
IX. 2000-2500 fm.	4
X. Over 2500 fm.	4

Provinces:-	Total Species:-
Atlantic Ocean:-	
Patagonian	49
Brazilian	89
West Indian	189
Eastern North American	184
Arctic Atlantic	114
Arctic European	187
Continental	288
Mediterranean	182
West African	87
South African	82
Indian Ocean:-	
East African	39
Kerguelen	22
Mascarene	110
Pacific Ocean:-	
New Zealand	81
South Australian	180
North Australian	80
Oceanic	72
Japanese	144
Hawaiian	42
Arctic Asiatic	61
Arctic Alaskan	67
South Alaskan	189
Californian	88
Mexican	19
Peruvian	47
Magellanic	89
Antarctic Ocean:-	44

Zone of depth:-

I. 0-20 fm.	611
II. 20-80 fm.	378
III. 80-100 fm.	270
IV. 100-200 fm.	213
V. 200-800 fm.	180
VI. 800-1000 fm.	30
VII. 1000-1800 fm.	11
VIII. 1800-2000 fm.	6
IX. 2000-2800 fm.	4
X. Over 2800 fm.	4

Table #14.

GEOGRAPHICAL DISTRIBUTION BY FAMILIES AND GENERA.

Genera.	Atlantic										Indian			Pacific.											Antarctic
	Pat.	Brаz.	W.I.	E.N.A.	Arc.Atl.	Arc.Eur.	Cont.	Med.	W.Af.	S.Af.	E.Af.	Kerg.	Masc.	N.Z.	S.Aus.	N.Aus.	Ocean.	Jap.	Haw.	Arc.As.	Arc.Pl.	S.Al.	Cal.	Mex.	Peru.	Magl.	
CLAVIDAE:-																										
Ascidioclava														1												
Balella																			1							
Campaniclava								1																		
Clava				1	1	1	4	2														1				
Corydendrium								1	1				2						2			1				
Endocrypta																						1				
Monobrachium				1	1	1														1						
Rhizogeton				1	1	1														1						
Tubiclava							3	3						2												
Turris							1																			
Turritopsis			1	1																						
Total:-			1	4	3	3	8	7	1				2	3					3	2		3				
CORYNIDAE:-																										
Acaulis				1	1	1																				
Actinogonium							1																			
Ceratella										1	2		1			1			1							
Cladocoryne				1			1	1	1				1					1								
Coryne					1	4	4	4	1			1		1								2				
Dendrocoryne																		2								
Dicoryne				1		1	2	2																		
Corynitis				1																						
Gemmaria			1	2			1	1										1						1	1	
Halocharis							1																			
Hydrichthella																		1								
Hydrichthys				1						1																
Hydrocoryne																		1								
Syncoryne	1			2	3	4	7	1						1	1							2	2		1	
Total:-	1		1	9	5	10	17	9	2	2	2	1	2	2	1	1		6	1			4	2	1	2	
HYDROLARIDAE:-																										
Lar							1																			
Total:-							1																			
BOUGAINVILLIDAE:-																										
Bimeria			1	2	1		5	2														3	5		1	
Bougainvillia			3	3	1	1	2	2									1	1			1		2			
Calyptospadix				1																						
Cionistes							1																			
Clathrozoon															1											
Clavactinia													1													
Clavopsella								1																		
Corynopsis							1																			
Hydradtinia				2	2	8	4	3	2			1						3		3	1	2	2		2	1
Hydrodendrium																			1							
Keratosum				1																						
Parawrightia										1																
Perigonimus	1			1	3	6	13	9	1		1		1					1				2	2		1	1	1
Podocoryne			2	2	1	3	3	2	1	1			2			1	1	1								1	
Provutella								1																		
Stylactis				1	1			1									1									1	
Total:-	1		6	13	9	17	29	21	4	2	1	1	4		1	1	3	6	1	3	2	7	11		4	4	1

Table 64.

BIOGEOGRAPHICAL DISTRIBUTION OF RADIOLARIA AND SPUMELLARIA.

Table #14(continued)

FAMILIES AND GENERA(Geographical)

Genera	Atlantic										Indian			Pacific												Antarctic
	Pat.	Braz.	W.I.	E.N.A.	Arc.Atl.	Arc.Eur.	Cont.	Med.	W.Af.	S.Af.	E.Af.	Kerg.	Masc.	N.Z.	S.Aus.	N.Aus.	Ocean.	Jap.	Haw.	Arc.As.	Arc.Al.	S.Al.	Cal.	Mex.	Peru.	Mag.	
PENNARIDAE:-																										
Cladonema							2	2																		
Heterostephanus						1																				
Pennaria			3	1				1	1		1		1		1		1	1								
Rhizotrichia							1																			
Stauridiosarsia							1																			
Vorticlava							3	1																		
Total:-			3	1		1	7	3	1		1		1		1		1	1								
EUDENDRIDAE:-																										
Eudendrium			9	12	5	9	9	10	4	1	1	2	6	1	1	3	3	5	2	3	1	7	4		4	1	3
Total:-			9	12	5	9	9	10	4	1	1	2	6	1	1	3	3	5	2	3	1	7	4		4	1	3
TUBULARIDAE:-																										
Amalthea		1			1	2																				
Branchiocerianthus											1		1					1				1		1		
Corymorpha	1			1	2	2	2											2			1		1			
Ectopleura				2			1										1									
Gymnogonos						1																				
Hybocodon				1		1																			1	
Hypolytus				1																						
Lampra						4																				2
Nemopsis			1																							
Pelagohydra														1												
Tubularia	1		1	9	3	6	9	5	2	1		1	3	1	3	2		1		2	2	3	4		3	1	3
Total:-	2	1	2	14	6	16	12	5	2	1	1	1	4	2	3	2	1	4		2	3	4	5	1	4	1	5
HALECIDAE:-																										
Campanecium																							1			
Halecium	6		6	11	9	12	12	12	4	5		1	3	3	4	1	1	5	1	5	1	20	5	5	1	2	2
Hemitheca														1												
Hydranthea						1											1									
Ophiodissa							1	1	1			1			1	1		1				1				1	
Phylactotheca																	1									
Total:-	6		6	11	9	13	13	13	5	5		2	3	4	5	2	3	6	1	5	1	21	6	5	1	3	2
CAMPANULINIDAE:-																										
Calycella				1	1	1	1	1			1		1	1				1	1	1		1	1			1
Campanulina						1	5						1					2				2			2	2
Lafoeina					2	2	1													1						1
Lovenella				2	1	1	2				1											1				
Operculariella				2	1	1	2	1					1		1			2	1							
Stegopoma				1	2	2	2		1									2	1	1	1	1				
Tetrapoma				1	1	1												1		1		1				
Zygodactyla				1	1																					
Total:-				8	9	9	13	2	1		2		3	1	1			8	3	4	1	6	1		2		4
LAFOEIDAE:-																										
Bonneviella					1	1												3			2	1				
Cryptolaria			3	1			1		1						1		2	2	3					1		
Grammaria	2		1	3	4	3	2	1	1			1					1	2	1	3	1	3			2	3	2
Halisiphonia															1											
Hebella	1		1	3	1	1	2	4	2	1	2		4	2	2	2	2	4	1	1	1	1				1	1
Lafoea			7	6	6	4	9	2	7	1	2		4	3	1		1		2	2	1	6	1	2	2	4	4
Lictorella				1	1	1	2						1			2	2		2			1		1		1	1
Scandia			1	1					1	1			1													
Toichopoma					1	1																				
Trichydra							1																			
Zygophylax				1			2		2				1	1			1	4						1		1
Total:-	3			14	15	14	11	19	7	14	3	2	1	11	6	5	4	9	15	9	6	5	12	1	5	4	9	9

Table #14(continued)

FAMILIES AND GENERA(Geographical)

Genera	Atlantic										Indian			Pacific												Antarctic
	Pat.	Braz.	W.I.	E.N.A.	Arc.Atl.	Arc.Eur.	Cont.	Med.	W.Af.	S.Af.	E.Af.	Kerg.	Masc.	N.Z.	S.Aus.	N.Aus.	Ocean.	Jap.	Haw.	Arc.As.	Arc.Al.	S.Al.	Cal.	Mex.	Peru	Magr.	
CAMPANULARIDAE:-																										
Campanularia	5	2	4	14	7	6	15	16	6	1	3	1	7	4	9	6	5	9	3	4	2	14	9		3	1	4
Clytia			7	7	1	2	2	5	3	1	1	1	5	2	1	1	3	4				6	5		1		
Gonothyraea		2		4	3	4	3	4	1								1	1			1	2	1		1	1	
Obelia	4	4	4	8	6	5	8	2	3	1	2	1	4	4	4	1	2	2		2	2	13	6	2	1	3	2
Orthopyxis	1		2	1	1	1	3	4	1					2	1	1					1	2	3		2	3	1
Silicularia	4									1		2		2	1	1									1	3	1
Thaumantias	1					1	1		1				1					1				1			1	1	
Total:-	15	8	17	34	17	19	32	31	16	4	6	5	17	14	16	10	11	17	3	6	6	38	23	2	10	12	8
SERTULARIDAE:-																										
Abietinaria				2	2	2	2	2	1	1								8		2	7	16	5	1			
Calamphora										1																	
Desmoscyphus													1			1											
Dictyocladium															2							1					
Diphasia		1	3	3	5	8	10	1	2	5	1		4	2	4	3		4	1	1	1	3	1				
Hydrallmania				1	1	1	1			1				1	1					1	1	2					
Idiella		1									1		1	1	1	1	1	1									
Lineolaria															2												
Odontotheca	1	1		1	1		1			2		1	1	1	1		1				1		1		1	1	
Pasythea			1	1					1				1		1	2	2	1	1								
Selaginopsis			1	1	2	5	1					1		1				10		5	9	5	1				
Sertularella	16	3	15	6	7	7	8	7	4	9	5	4	5	15	20	6	6	16	5	5	7	10	5	2	9	16	9
Sertularia	1	3	12	5	2	1	5	3	5	4	2		7	9	27	12	5	2	1	1		1	4	1			1
Staurotheca	1																1										1
Stereotheca										1																	
Thuiella														1													
Thuiaria		1	3	15	12	7	8	3	1	5	1	1	5	2	6	2		7	1	5	10	10			1		
Thyroscyphus		1	2							1	1		2			1	1	1									
Total:-	19	11	37	35	32	31	36	16	14	30	11	7	27	33	65	28	17	50	9	20	36	48	17	4	11	17	11
PLUMULARIDAE:-																										
Acanthella																1	1										
Acanthocladium																	1										
Acladia										1																	
Aglaophenia	1	6	28	6		4	7	7	4	13	4		8	6	19	9	5	5	1			1	7		1		
Aglaophenopsis			2	1																							
Antenella			1				2	2	1	2			2		1		1	1	1				1				
Antenellopsis																		2									
Antennopsis			5							1																	
Antennularia			2	4	1	1	2	2	3	4				1	1	1		2									
Callicarpa			1																								
Calvinia			1																								
Cladocarpus			13	6	3	3	3															1					
Diplopteron			3																								
Gattya —?																											
Halicornaria		1	3				1			1	2		6	1	8	2	3	5	2								
Halicornopsis													1		1												
Halopteris			1																								
Hemicarpus													1				1										
Heteroplon															1												
Hippurella			1																								
Lytocarpus		2	6	1			1	2	3	1	2		7		3	5	6	4	4								
Monostaechas			1	1					1				1			1	1	1	2								
Monotheca			1	1			1	1							1	1											
Nemertesia			1			1	2	4	3	1					1			1									
Nuditheca																					1						
Ophinella						1																					
Plumularia	1		16	5	1	5	11	9	7	8	3	1	2	6	21	6	8	3	5		1	7	9	1	4	2	
Polyplumularia			1			1	1																				
Pycnotheca										1					2			1					1				
Schizotricha			2	2		1	1					1					1									*	1
Sciurella																1											
Streptocaulus									1																		
Thecocarpus			4	1		1	1	1	1	1	1		2	1	2	2	2	1	1								
Total:-	2	9	93	28	5	18	33	28	24	34	12	2	30	15	61	29	30	26	16		2	9	18	1	5	2	1

Table #15.

BATHYMETRICAL DISTRIBUTION BY FAMILIES AND GENERA.

Genera.	I. 0-20 fm.	II. 20-50 fm.	III. 50-100 fm.	IV. 100-200 fm.	V. 200-500 fm.	VI. 500-1000 fm.	VII. 1000-1500 fm.	VIII. 1500-2000 fm.	IX. 2000-2500 fm.	X. 2500+ fm.
CLAVIDAE:-										
Ascidioclava	1									
Balella				1						
Campaniclava	1									
Clava	5									
Corydendrium	4	1	3	2	1					
Endocrypta	1									
Monobrachium	1									
Rhizogeton	2									
Tubiclava	5	1	1							
Turris	1									
Turritopsis	1									
Total:-	22	2	4	3	1					
CORYNIDAE:-										
Acaulis	1	1	1							
Actinogonium	—									
Ceratella	1	1	1							
Cladocoryne	3									
Coryne	10	1	2							
Dendrocoryne	2	1								
Dicoryne	2	1	1	1						
Corynitis	1									
Gemmaria	3	1	1	1	1					
Halocharis	1									
Hydrichthella	1									
Hydrichthys	"on fish"									
Hydrocoryne	1									
Syncoryne	9	3	1							
Total:-	35	9	7	2	1					
HYDROLARIDAE:-										
Lar	1									
Total:-	1									
BOUGAINVILLIDAE:-										
Bimeria	10	2	1		2					
Bougainvillidae	8	1	1							
Calyptospadix	1									
Cionistes	1									
Clathrozoon	—									
Clavactinia	1									
Clavopsella	1									
Corynopsis	x									
Hydractinia	15	3	5	3	1	1				
Hydrodendrium	1									
Keratosum	1									
Parawrightia	—									
Perigonimus	18	5	8	4	2					
Podocoryne	4	2	1	1						
Provutella	1	1								
Stylactis	3							1		1
Total:-	65	14	16	8	5	1		1		1

Table #15(continued)

FAMILIES AND GENERA(Bathymetrical)

Genera.	I. 0-20 fm.	II. 20-50 fm.	III 50-100 fm.	IV. 100-200 fm.	V. 200-500 fm.	VI. 500-1000 fm.	VII. 1000-1500 fm.	VIII. 1500-2000 fm.	IX. 2000-2500 fm.	X. 2500 + fm.
PENNARIDAE:-										
Cladonema	2									
Heterostephanus	1									
Pennaria	4									
Rhizotrichia	1									
Stauridiosarsia	1									
Vorticlava	3									
Total:-	12									
EUDENDRIDAE:-										
Eudendrium	28	12	9	6	4	1				
Total:-	28	12	9	6	4	1				
TUBULARIDAE:-										
Amalthea	2	1	1							
Branchiocerianthus	1	1	1	1	2	1	1	1	1	
Corymorpha	5	3	2	1						
Ectopleura	3									
Gymnogonos					1					
Hybocodon	1	1	1	1	1					
Hypolytus	1									
Lampra	1				2		1			
Nemopsis "fl."										
Pelagohydra "fl."										
Tubularia	22	8	3	6	1	1	1			
Total:-	36	14	8	9	7	2	3	1	1	
HALECIDAE:-										
Campalecium	1									
Halecium	32	16	14	10	6					
Hemitheca	1									
Hydranthea	2	1								
Ophiodissa	3	2	1							
Phylactotheca	1									
Total:-	40	19	15	10	6					
CAMPANULINIDAE:-										
Calycella	3	1	1	1	1					
Campanulina	7	4	2	2	3	1	1	1	1	1
Lafoeina	3	2	2	1	1					
Lovenella	3		1	1						
Operculariella	3	2		1						
Stegopoma	1	1	1	2	2	1				
Tetrapoma	1	1	1	1						
Zygodactyla —										
Total:-	21	11	8	9	7	2	1	1	1	1
LAFOEIDAE:-										
Bonneviella		1	1	2	4	1				
Cryptolaria	3	2	2	4	4	1			1	1
Grammaria	4	5	7	3	1					
Halisiphonia										1
Hebella	7	6	3	2	1					
Lafoea	6	7	8	9	9	3				
Lictorella	3	2	2	4	2					
Scandia fl.										
Toichopoma	1	1	1	1						
Trichydra	1									
Zygophylax		2	3	3	4	1				
Total:-	25	26	27	28	25	6			1	2

Table #15(continued)

FAMILIES AND GENERA(Bathymetrical)

Genera.	I. 0-20 fms.	II. 20-50 fms.	III. 50-100 fms.	IV. 100-200 fms.	V. 200-500 fms.	VI. 500-1000 fms.	VII. 1000-1500 fms.	VIII. 1500-2000 fms.	IX. 2000-2500 fms.	X. 2500 + fms.
CAMPANULARIDAE:-										
Campanularia	44	20	15	12	7					
Clytia	18	5	2							
Gonothyraea	5	5	3	2						
Obelia	20	9	3	1	1	1				
Orthopyxis	6	2	1							
Silicularia	6									
Thaumantias	—									
Total:-	99	41	24	15	8	1				
SERTULARIDAE:-										
Abietinaria	4	8	7	4	3	1				
Calamphora	1									
Desmoscyphus	2									
Dictyocladium	1	2	1							
Diphasia	5	11	10	9	6	3				
Hydrallmania	2	1	1	1	1	1	1			
Idiella	1	1	1	1	1	1	1			
Lineolaria	1									
Odontotheca	1	1	1	1	1					
Pasythea	2	1								
Selaginopsis	1	6	1		1					
Sertularella	39	30	31	21	14	3	2	2	1	
Sertularia	88	10	2	2	2					
Staurotheca			2		1					
Stereotheca	—									
Thuiella	—									
Thuiaria	17	16	9	6	3					
Thyroscyphus	5	1								
Total:-	120	88	66	45	33	9	4	2	1	
PLUMULARIDAE:-										
Acanthella	1									
Acanthocladium	1	1								
Acladia	—									
Aglaophenia	31	20	21	12	6	1	2			
Aglaophenopsis					2		1	1		
Antenella	3	4	4	4	3					
Antenellopsis	2	1								
Antennopsis		1		4	3					
Antennularia	3	5	6	5	4					
Callicarpa	—									
Calvinia					1					
Cladocarpus	1	4	6	13	10	3				
Diplopteron				2	1					
Gattya	1									
Halicornaria	11	8	9	3	2	1				
Halicornopsis	1	1	1							
Halopteris	1	1								
Hemicarpus	1	1								
Heteroplon		1								
Hippurella				1						
Lytocarpus	10	7	6	5	5	1				
Monostaechas	1	1	2	2	1					
Monotheca	2									
Nemertesia	2	1	3	2	1					
Nuditheca	"bch."									
Ophinella			1							
Plumularia	29	19	20	18	16	2				
Polyplumularia			1	1	2					
Pycnotheca		1	1							
Schizotricha	3	2	3	2	2					
Sciurella	1									
Streptocaulus				1						
Thecocarpus	2	3	2	3	4					
Total:-	107	82	86	78	63	8	3	1		

Table #16(continued)

[illegible] AND [illegible] (Bathymetrical)

Species	I. 0-20 fm	II. 20-50 fm	III. 50-100 fm	IV. 100-200 fm	V. 200-500 fm	VI. 500-1000 fm	VII. 1000-1500 fm	VIII. 1500-2000 fm	IX. 2000-2500 fm	X. 2500-3000 fm
[illegible]:-										
[illegible]	44	20	15	12	7					
[illegible]	18	5	2							
[illegible]	5	5	3	2						
[illegible]	20	9	3	1	1	1				
[illegible]	6	2	1							
[illegible]	6									
Total:-	99	41	24	15	8	1				
[illegible]:-										
[illegible]	4	8	7	4	3	1				
[illegible]	1									
[illegible]	2									
[illegible]	1	2	1							
[illegible]	5	11	10	9	6	3				
[illegible]	2	1	1	1	1	1	1			
[illegible]	1	1	1	1	1	1	1			
[illegible]	1									
[illegible]	1	1	1	1	1					
[illegible]	2	1								
[illegible]	1	6	1		1					
[illegible]	34	30	31	21	14	3	2	2	1	
[illegible]	33	10	2	2	2					
[illegible]			2		1					
[illegible]										
[illegible]	17	16	9	6	3					
[illegible]	5	1								
Total:-	120	88	66	45	33	9	4	2	1	
[illegible]:-										
[illegible]	1									
[illegible]	1	1								
[illegible]										
[illegible]	31	20	21	12	6	1	2			
[illegible]					2		1	1		
[illegible]	3	4	4	4	3					
[illegible]	2	1								
[illegible]		1		4	3					
[illegible]	3	5	6	5	4					
[illegible]										
[illegible]					1					
[illegible]	1	4	6	13	10	3				
[illegible]				2	1					
[illegible]	5									
[illegible]	4	8	9	3	2	1				
[illegible]	1	1	1							
[illegible]	1	1								
[illegible]	1	1								
[illegible]		1								
[illegible]				1						
[illegible]	10	7	6	5	5	1				
[illegible]	1	1	2	2	1					
[illegible]	2									
[illegible]										
[illegible]		2	3	3	4	1				
Total:-	25	26	27	28	25	6			1	[illegible]

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